



COLONY AND PROTECTORATE OF KENYA

DEPARTMENT OF AGRICULTURE
ANNUAL REPORT
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Note.—The Annual Report, Coffee Services, is not included in this report, as from 1952 it is to be published separately.

ANNUAL REPORT OF THE SENIOR ENTOMOLOGIST, 1953

Plant Protection

IMPORTATION OF PLANTS

Plant importation permits issued during the year totalled 1,293, being again an advance on the number issued the year before. The number of parcels imported through the Post Office and inspected at the Scott Laboratories amounted to 2,046. A large amount of plant material was also imported through Eastleigh and Nairobi West. Two hundred and twenty-one consignments were subjected to fumigation or other special treatment. Four hundred and forty-four consignments were intercepted as being in some way irregular, most of these were released after examination and treatment, but a small number were either re-exported or destroyed. Fines collected amounted to Sh. 234.

EXPORT OF PLANTS

The number of consignments of plants examined for plant health certificates was 374. A number of these required fumigation, either because of infestation, or as demanded by the country of destination.

Insects Intercepted

COCCIDAE—		From	On
<i>Chrysomphalus dictyospermi</i>		Belgian Congo	Rose cuttings
<i>Lepidosaphes beckii</i>	.. ..	Aden	Grapefruit
<i>Parlatoria proteus</i>	.. ..	Aden	Grapefruit
APHIDIDAE—			
<i>Macrosiphum euphorbiae</i>	..	England	Hydrangea
LEPIDOPTERA—			
<i>Argyroplote leucotreta</i>	..	Tanganyika	Tea seed
<i>Argyroplote aprobola</i>	.. ..	Tanganyika	Tea seed
<i>Auximobasis glandulella</i>	..	Tanganyika	Tea seed
COLEOPTERA—			
<i>Callosobruchus phaseoli</i>	..	Baroda India	Dolichos seed
HYMENOPTERA—			
<i>Pheidole megacephala</i>	.. ..	U.S.A.	Coffee seedlings
ISOPTERA—			
Unidentified	.. ..	U.S.A.	Coffee seedlings
ACARINA—			
Unidentified	.. ..	England North Ireland Scotland Mauritius Tanganyika	Various plants
<i>Rhizoglyphus</i> sp.	.. ..	Holland	Flower bulbs

INVESTIGATIONS

The operation of the Plant Protection Ordinance entails investigations into means of treating various classes of produce. Methyl bromide was shown to impair the germination of tea seed. It was suggested that all oil seeds might be affected in the same way but experiments showed that there was no impairment of germination with methyl bromide fumigation of linseed, colza, sunflower, groundnut, castor oil, or niger oil seeds.

Tomato seeds were treated with hot water against *Corynebacterium michiganense* at a temperature of $54^{\circ}\text{C.} \pm 1^{\circ}\text{C.}$ without impairing germination.

Cut flowers were treated by H.C.N. fumigation ($1\frac{1}{2}$ oz. per 1,000 cu. ft. for 15 minutes) against thrips. No damage was done to the flowers by this treatment.

Azobenzene smoke was tried against mite infested planting material, but results were not sufficiently satisfactory.

Experiments in the disinfection of fresh fruit infested with Trypetid (Fruit Fly) larvae were successful. The fruit was completely disinfested with 6 ozs. of ethylene dibromide per 1,000 cu. ft. Following this work it was possible to announce a relaxation of the complete ban on fruit from Asia.

The help of the Senior Plant Pathologist and his section throughout the year is acknowledged. As usual the closest co-operation was maintained. Thanks are also given to the Chief Grader and Inspector, and his staff for co-operation throughout the year.

Stored Products

The experimental work carried out is reported on by Mr. S. Kockum and Miss J. Slow.

"TREATMENT OF THE FABRIC OF BAGS WITH INSECTICIDE

An experiment was conducted to determine whether grain was protected from infestation by treatment with Piperonyl-butoxide Pyrethrins (Pybuthrin). Treated bags contained fewer insects than untreated, nevertheless the infestation in them was considerable and the protection insufficient under local conditions.

TREATMENT OF GRAIN IN BAGS WITH INSECTICIDE

An experiment with dust treatments of two strengths of Pybuthrin, Piperonyl Butoxide by itself and Pyrethrum dust with untreated control bags was set up and was still running at the end of the year.

EFFECT OF B.H.C. ON BRUCHIDS

Preliminary laboratory experiments in glass jars indicated that adult *Callosobruchus maculatus* were killed by as little as 0.125 parts per million gamma B.H.C. but trials with heavily infested cowpeas in small bags did not bear this out and further experiments to determine the B.H.C. dosage required in practice will need to be carried out.

SURVEY OF AFRICAN STORAGE METHODS

A survey was carried out in the South Nyanza Province and an illustrated report prepared.

FUMIGATION WITH METHYL BROMIDE

Large scale fumigation under gasproof sheeting was carried out with 4,000 bags of infested maize. This preliminary experiment gave useful experience and very promising results. Further large scale experiments were planned but these could not be completed because of abnormal storage needs for imported maize.

CRIB EXPERIMENTS

The results from the 1952 crib experiment were computed and published in the *East African Agricultural Journal*, October, 1953. A new experiment was carried out using different strengths of gamma B.H.C. and also with different treatments of the outside surfaces with pyrethrum dusts. These pyrethrum treatments gave negative results but final figures of the whole experiment are not yet available. A third experiment is planned for 1954 where different materials covering the crib walls will be tried in connexion with B.H.C. dusting, as it has been demonstrated that infestation is greater and hence more difficult to eliminate on the exposed surfaces of cribs."

"LIFE CYCLES OF STORED PRODUCTS INSECTS

An experiment was carried out to ascertain the most satisfactory foods to use for routine rearing purposes. The lengths of the life cycles of *Calandra oryzae*, *Oryzaephilus surinamensis*, and *Tribolium castaneum* were determined on whole maize, broken maize and maize meal. The results indicated that the three insects have life cycles of a similar length, i.e. about six weeks, at temperatures between 71 and 88°F. and relative humidity between 61 and 93 per cent. *C. oryzae* was the only one which bred successfully on whole maize. *Tribolium* on maize meal showed the highest rate of emergence, although that of *Calandra* on broken maize was also high. *Oryzaephilus* did not breed well on any of the three media.

FLOTATION OF DAMAGED WHEAT GRAINS

An experiment was carried out on the separation of damaged and sound wheat grains by flotation, using sodium chloride in 1, 2, 5, 7.5 and 10 per cent solutions. The lowest percentage errors (determined by examination of samples) were in the 1 per cent solution and in water, but these were too high for the method to be of practical value.

The following stored products insects were identified from various produce collected:—

Acanthoscelides obtectus.—Beans, millet, green gram.

Oryzaephilus surinamensis.—Maize.

Oryzaephilus mercator.—Groundnuts, green gram, maize.

Tribolium castaneum.—Groundnuts, maize.

Tribolium confusum.—Millet.

Calandra oryzae.—Maize.

Callosobruchus chinensis.—Green gram.

Callosobruchus maculatus.—Cowpeas, green gram, millet.

Callosobruchus phaseoli.—Cowpeas.

Carpophilus dimidiatus.—Groundnuts.

Lophocateres pusillus.—Maize.

PARASITES OF *Calandra Oryzae*

A study of the parasite *Aplastomorpha calandrae* was begun, since the general experimentation had shown that the parasite is an important factor influencing the populations of the beetle. Efforts to rear the insect using the technique described by Cotton (*Jl. Agric. Res.*, 23, p. 549, 1923), namely the

placing of *Calandra* larvae in gelatine capsules through which the parasite oviposited, were unsuccessful, and further rearing work is being continued. The work will be extended to include experiments to compare the populations in parasite free grain bags, and bags to which the parasites have access."

General Insecticide Work

Mr. P. T. Walker, an officer of the Colonial Insecticide Research, was based on the Scott Laboratories throughout the year, apart from visits to Kitale and Nakuru.

He undertook the following work:—

SWEET POTATO WEEVIL (*Cylas puncticollis*)

Laboratory tests, using a Potter tower, were carried out against adults of the Sweet Potato Weevil. Of the following emulsions, D.D.T., gamma B.H.C., Aldrin and Dieldrin, D.D.T. was the most rapid in its action.

CHAFER GRUB (*Schizonycha* sp.)

Grubs were planted in one-twentieth acre plots at Kitale to give a population density of 190,000 per acre. These plots were sown with barley and soil insecticides and seed dressings were applied. Aldrin 2½ per cent dust at the rate of 40 lb. per acre gave a highly significant increase in yield. Aldrin 25 per cent wettable powder used as a seed dressing at the rate of 1½ oz. per bushel and Mergamma seed dressings were slightly better than the control.

ARMYWORM (*Laphygma exempta*)

Small-scale field trials were carried out against Armyworm caterpillars. Endrin and Isodrin emulsions were used at 5 oz. per acre and D.D.T. emulsion at 7.5 oz. per acre in the form of spray. Endrin and D.D.T. were almost equal in effect and were superior to Isodrin. They gave virtually 100 per cent kill after eight days, but Endrin was slightly more effective within 18 hours. Of dusts used against the caterpillars Parathion was more effective at 0.75 per cent than D.D.T. at 5 per cent or than gamma B.H.C. at 2.9 per cent and 0.65 per cent. In a further trial it was found that Endrin at the rates of 5 oz. per acre and 2½ oz. per acre gave 100 per cent kill in three days when in 50 gallons of water, but in 25 gallons of water it was less effective.

MAIZE STALK BORER (*Busseola fusca*)

A satisfactory technique of rearing this species in the laboratory was worked out and a supply of larvae was thus available, for both field and laboratory experiments.

The first instar larvae remain on the surface of the leaf for at least half an hour before entering the funnel but penetration of the stem does not take place until two or three weeks later. There is thus ample opportunity for them to pick up a toxic dose of an insecticide. Dusting with D.D.T. dusts gave after 24 hours a mortality of 100 per cent with 2.5 per cent and of 79 per cent with 1 per cent. No mortality resulted from dusting with diatomite. With emulsions gamma B.H.C. gave a higher and quicker kill than D.D.T., but residues of D.D.T. were more effective after 20 hours. Derrisol was tested but its residues were found to be ineffective. Larvae dipped in it, however, are killed if the contact is prolonged. In a field test it was as effective as 1 per cent D.D.T. diatomite dust.

Systematic Study of Coccidæ

Mr. de Lotto has continued his work on the Coccidae and has also continued general identification work for other officers of the section, and for other sections and departments. A detailed study of Ethiopian Mealy Bugs (*Pseudococcidae*) is planned. This is important work as the systematics of this important economic family are in great need of clarification.

He reports as follows:—

"In 1953 the work was mostly devoted to the systematic study of the material previously collected or existing in the departmental collections.

The first group dealt with was the Diaspididae. The following is a complete current list of the described species from Kenya and other areas of East Africa.

(a) ASPIDIOTINI:

- Abgrallaspis cyanophylli* (Sign)
- A. palmae* (Ckll.)
- **Aonidia subsimplex* Hall
- Aonidiella aurantii* (Mask.)
- A. orientalis* (Newst.)
- A. replicata* (Lind.)
- Aspidiotus destructor* Sign
- **A. fimbriatus capensis* Newst.
- A. hederæ* (Vall.)
- **A. gowdeyi* Newst.
- **A. vernoniae* Hall
- Chrysomphalus dictyospermi* (Morg.)
- C. ficus* Ashm.
- Duplaspidiotus tesseratus* (Charmoy)
- Furcaspis capensis* (Wlk.)
- **Gymnaspis africana* Newst.
- Hemiberlesia lataniae* (Sign)
- H. rapax* (Comst.)
- H. tectonae* (Lind.)
- H. zizyphi securidacæ* Hall
- Lindingaspis opima* (Silv.)
- **Pseudaonidia baikeae* Newst.
- P. quadriareolata* Mal.
- P. trilobitiformis* Green
- Selenaspis articulatus* (Morg.)
- S. incisus* Lind.
- **S. lounsburyi* Marl.
- S. silvaticus* Lind.
- S. spinosus* Laing.
- Varicaspis fiornineides* (Newst.)

(b) DIASPIDINI:

- Africaspis chionaspiformis* (Newst.)
- A. fici* (Newst.)
- Aonidomytilus albus* (Ckll.)
- Aulacaspis cinnamomi* Newst.
- A. tegalensis* (Zehntner)
- Clavaspis herculeana* (Doane & Hadden)
- Cooleyaspis praelonga* (Newst.)

(b) DIASPIDINI—(Contd.):

Dentaspis hargreavesi (Newst.)
Diaspis boisduvalii Sign
D. bromeliae (Kerner)
D. spatulata Hall
Howardia biclavus (Comst.)
Ichnaspis bipindensis Ling.
I. longirostris (Sign)
Ledaspis reticulata (Mal.)
Lepidosaphes beckii (Newm.)
Leucaspis cockerelli (Charmoy)
Nelaspis exalbida (Ckll.)
Pinnaspis sirachani (Cooley)
Pseudaulacaspis pentagona (Targ.)
Tecaspis fiorii (Leon.)
T. retigera (Ckll.)

(c) ODNASPIDINI:

Odonaspis secreta Ckll.
Poliaspoides formosana (Takah.)

* Species whose generic nomenclature has not yet been settled.

The following are new species which are now awaiting description:—

(a) ASPIDIOTINI:

Aonidiella sp.
Melanaspis sp.
Quadraspidiotus sp.
Hemiberlesia 2 spp.
Aspidiotus sp.
Lindingaspis 2 spp.
Selenaspis sp.
Andaspis sp.
Anotaspis sp.

(b) DIASPIDINI:

Aonidomytilus sp.
Contigaspis sp.
Diaspis 4 spp.
Duplachionaspis sp.
Inchoaspis sp.
Ledaspis 3 spp.
Lepidosaphes 3 spp.
Phenacaspis sp.
Pinnaspis sp.
Pseudaulacaspis sp.
Rolaspis sp. 6 spp.
Tecaspis 2 spp.

Ten more new species are not included in the list as the material at hand is too scanty for an adequate description, and they await further collecting.

A similar study on the whole group of Mealy Bugs (*Pseudococcidae*) has already been started."

General Investigations

Mr. J. F. Graham was based on the Scott Laboratories. He reports as follows:—

"REARING OF TINGIDS FOR BIOLOGICAL CONTROL

The rearing of *Teleonemia scrupulosa* begun in the previous year, had met with little success and early in January there were only three adults left. Fortunately there were a few nymphs and the stock did not die out.

The insects were kept in Dietz lamp glasses, the wider end uppermost and covered with muslin and the other end over a small Lantana plant. The latter was surrounded by a stiff card and the lamp glass was attached to this by paraffin wax. The orifice in the card, around the stem of the plant, was

also filled with wax. A tube of water, stoppered by cotton wool, contained a few cut Lantana flowers; it has been found elsewhere that the bugs must have access to these or few eggs are laid. The plant pots containing the Lantana plants were placed in metal trays which could be flooded with water as required and these were kept in racks in the insectary at a mean temperature of about 80°F.

During February and March numbers increased slightly but during June they began to drop and by early July only ten adults survived. Because of the increase in the bright dry months of the year it was thought that light might be an important factor and so strip lighting was installed. This was followed by an increase in their numbers, which reached 60 in August, almost 200 in September and about 300 in October.

It was then decided to make a liberation at Matuga and this was done in the middle of October, when 240 adults were sent. These travelled well and have passed several generations in the field. At the temperatures maintained in the insectary the eggs take about eight days to hatch and total life cycle is about 25 days. Adults remain alive in the jars for approximately two months but normally do not spend more than two or three days on any one plant. If kept longer more eggs are laid than required and the plant sheds its leaves before the nymphs become mature. Even after two days it is often necessary to introduce cut Lantana leaves in order to feed all the nymphs produced. If the plant dies when the nymphs are very small the latter find difficulty in moving on to new leaves. With large nymphs however such movements take place rapidly and there is a very low mortality. The breeding continued well for the remainder of the year.

FIELD INFESTATION OF BRUCHIDS

Haricot beans exported from Kenya are usually infested with Bruchid beetles, notably *Acanthoscelides obtectus*. This makes them compare unfavourably with those from other countries. These Bruchids infest the beans on the growing crop and their numbers build up rapidly in storage after harvest. Trials were carried out at Embu to ascertain to what extent field infestation took place and whether dusting with D.D.T. had any appreciable effect in reducing it. One series of plots was dusted with a single application of 2½ per cent D.D.T. and another series had two dustings of 2½ per cent D.D.T. separated by a fortnight. A third and fourth series were treated with one and two applications of 5 per cent D.D.T. respectively. Samples of harvested beans from these and the control plots were examined for Bruchid damage and the percentage of infested beans was ascertained. For the control plots this was approximately 1.2 per cent whereas in the treated plots it varied between 0.23 per cent and 0.38 per cent. In a control plot under different conditions at the Scott Laboratories it was 0.17 per cent. The difference between the control and the best treatment was thus only one per cent and was obviously not worth the expense and trouble of dusting the growing crop. Treatment of the beans during storage as soon as possible after harvesting is much simpler and more effective and, if 0.04 per cent gamma B.H.C. is used, the cost is very small compared with that of field dusting.

INSECTICIDAL CONTROL OF THE BLACK MAIZE BEETLE (*Heteronychus consimilis*)

Tests using various insecticides applied to the soil, and as seed dressings were carried out in 1951 by Dr. Le Pelley and Mr. Goddard. Some of these insecticides were used again in 1953 to confirm these results. Conditions

were drier than usual and in marked contrast to the abnormally wet ones in 1951. Yields were smaller but there was a substantial increase in some of the plots where insecticides were used. Yields expressed as percentages of that of the controls were as follows:—

Mergamma A	..	3 oz. per bushel of seed	..	149.6
Mergamma B	..	3 oz. per bushel of seed	..	101.8
Aldrin	..	18 lbs. per acre of 2½ per cent dust		132.2
Control	..	..	..	100

The reason for the low yield with Mergamma B, which is the most concentrated of the three insecticides used, is not known.

AERIAL SPRAYING OF MAIZE

Because of the scarcity of labour, hand dressing of maize with D.D.T. dust or Derrisol liquid is not always possible and some farmers are now spraying D.D.T. emulsion from their own spraying machines. An aerial spraying experiment was carried out in collaboration with Colonial Insecticide Research, in the Rongai area, using a 2½ per cent D.D.T. spray. Unfortunately drought conditions intervened and the crop made little progress. The results, assessed by Mr. Walker, showed that in one control 2.5 per cent kills were infested rising to 10.38 per cent after eight weeks whereas in the sprayed area the corresponding figures were 1.25 per cent rising to 4.04 per cent. Under the conditions of the trial the spraying was therefore of some value but not up to the standard required.

JACARANDA BLIGHT

The liberation of *Hyperaspis jocosa* continues to be marked with success in the Nairobi area and *Orthezia insignis*, the Jacaranda Blight, is now uncommon. It was reported from only one site within the Municipality during the year. Elsewhere, liberations were made in the Ruiru, Thika, Ngong, Makuyu, Machakos, Kiambu, Mitubiri and Embu areas. A small breeding stock is being maintained at the laboratories and this can be expanded should the demand for it increase.

RED SPIDER MITE

An infestation of red spider mite in Fuchsias was sprayed with highly satisfactory results. The miticides used were Derrisol to kill the adults, and Para Chlorophenyl Benzene Sulphonate (Murvesco) which is ovicidal in action. Sample leaves from the sprayed plants, examined a fortnight later were all free from mites and their eggs except in one case where one adult mite and a few eggs remained."

RHINOCEROS BEETLE (*Oryctes monoceros*)

This insect is one of the major pests of coconuts over the whole of the coastal area. The campaign to destroy dead coconut trees and improve the general sanitation of plantations is continuing, but there are many areas where it has not yet been vigorously enforced. Until such measures are taken in all districts, severe damage will continue.

In some of the traps operated at Msambweni Mr. Sethi noticed a fungus on the *Oryctes* larvae which was identified by the Senior Plant Pathologist as a species of *Metarrhizium anisopliae*. Trials were made in the laboratory to see if this fungus could be used for destruction of larvae but they were not successful.

COREID BUG OF COCONUTS (*Theraptus* sp.)

The work on this insect was several times interrupted and for long periods, by reason of the Entomologist being called up for Emergency police duties. A hand-spraying experiment was carried out, and also observations on ants.

Miscellaneous Pests

The following pests were recorded during the year:—

<i>Lampides boeticus</i> ..	Dolichos falcatus ..	Nairobi
<i>Aulacaspis cinnamomi</i> ..	Mango	Nairobi, Sagana Mitubiri
<i>Epicauta albovittata</i> ..	Brinjal, Spinach beet	Matuga
<i>Selenaspidus articulatus</i> ..	Orange	Kitale
<i>Luperodes quaternus</i> ..	Gram	Kitui
<i>Pericerya purchasi</i> ..	Citrus	Dagoretti
<i>Ceroplesis signata</i> ..	Tea	Sotik
<i>Epimadiza nigra</i>	Gladiolus	Maseno
<i>Plutella maculipennis</i> ..	Cabbage	Ngoliba, Seme
<i>Brevicoryne brassicae</i> ..	Cabbage	Nairobi, Seme Thomson's Falls
<i>Crociodolomia binotalis</i> ..	Cabbage	Nairobi Thomson's Falls
<i>Ceratitis capitata</i>	Peaches	Ngong
<i>Eriococcus araucariae</i> ..	Conifer	Eldoret
<i>Trioza merwei</i>	Citrus	Wundanyi
<i>Aonidiella aurantii</i> ..	Roses	Kiambu
<i>Argyroplote leucotreta</i> ..	Avocado, Orange ..	Nairobi
<i>Marasmia trapezalis</i> ..	Maize	Nyanza Province
<i>Nematocerus</i> sp.	Maize	Kitale
<i>Dasus simplex</i>	Lucerne, Wheat ..	Eldoret, Naivasha
<i>Diastocera reticulata</i> ..	Cashew	Msambweni
<i>Bagrada picta</i>	Cruciferous seedlings	Eldoret
<i>Melanagromyza phaseoli</i>	Beans	Ngong
<i>Coccus hesperidum</i> ..	Black Wattle ..	Eldoret
<i>Epilachna hirta</i>	Wheat	Eldoret
<i>Sesamia calamistis</i> ..	Maize	Homa Bay
<i>Chaetosiphon fragaefolii</i>	Strawberries ..	Thika
<i>Coryna vilis</i>	Groundnuts ..	Kibos
<i>Aphis craccivora</i>	Groundnuts ..	Kibos
<i>Phymateus viridipes</i> ..	Garden plants ..	Nakuru
<i>Cosmopolites sordidus</i> ..	Banana	Seme
<i>Coryna dorsalis</i>	Hibiscus	Rongai
<i>C. katanensis</i>	Hibiscus	Rongai
<i>Heliothis armigera</i> ..	Tomato	Nairobi
<i>Oxycarenus gossypinus</i> ..	Orange	Timau
<i>Scolitantides subditus</i> ..	Gromwell	Nakuru
<i>Papilio</i> sp.	Orange	Simba
<i>Heteronychus</i> sp.	Maize	Makuyu
<i>Vanessa cardui</i>	Hibiscus	Rongai
<i>Anoplostetha lactator</i> ..	Citrus	Matuga
<i>Dysdercus cardinalis</i> ..	Ochra	Matuga

INSECT COLLECTION, COMPILATION OF RECORDS AND INFORMATION ON AGRICULTURAL INSECTS

For many years past, due to the war and until recently shortage of staff, work on the collections of the Section could not be kept up to date. Very large numbers of specimens remained unclassified and a great deal of past economic work and valuable records were therefore not available. A good start was made to get the collections into order and to work through the accumulated unclassified material. At the same time a complete card index of East African insects in families of agricultural importance was begun and great progress was made. This will be followed by compilation of available economic information. If this work can be continued for some years the publication of a basic work on agricultural entomology of East Africa will be in sight.

Insects Identified in 1953, being New Records

BRUCHIDAE—

<i>Acanthoscelides obtectus</i> ..	Beans	Mbooni
<i>Callosobruchus rhodesianus</i>	Dolichos sp.	Kilima Kiu
<i>Bruchidius atrolineatus</i> ..	Cowpeas	Makindu

NITIDULIDAE—

<i>Carpophilus dimidiatus</i>			
v. <i>mutilatus</i>	Maize	Mbooni	

MYCETOPHAGIDAE—

<i>Typhaea stercorea</i>	Stored products ..	Kikambulu
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LYMEXYLONIDAE—

<i>Atractocerus brevicornis</i> ..	Cashew nut tree ..	Matuga
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BUPRESTIDAE—

<i>Sphenoptera oculifrons</i> ..	Cowpeas	Matuga
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ANTHOMYIIDAE—

<i>Hylmeyia arambourgi</i> ..	Barley	Solai
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BIOLOGICAL CONTROL

Further insect enemies of the Jacaranda Blight, *Orthezia insignis*, were imported, the insects being discovered and shipped by the Commonwealth Institute of Biological Control from their station in Trinidad. Several shipments were received, the following insects being included—

Hyperaspis donzeli, Muls. (Coccinellidae)

Hyperaspis sp.

Gitonides braziliensis, Costa Lima (Drosophilidae)

Dipteron (Chamaemyidae)

of these *Hyperaspis donzeli* was in production at the end of the year but not in sufficient numbers for liberation. The other insects were not received alive in sufficient numbers to be put into production. Further plans to continue this work had to be discontinued early in 1954 owing to lack of staff for the work.

Mr. Van den Bosch from California visited the laboratories in connexion with the biological control of *Saissetia oleae*. He collected and shipped a number of parasites.

Publications

R. Le Pelley and S. Kockum, "Experiments in the use of Insecticides for the Protection of Grain in Storage". *Bull Ent. Res.*, 1954 (in press).

S. Kockum, "Protection of Cob Maize Stored in Cribs", *E.A. Agricultural Journal*, October, 1953, pp. 69-73.

G. de Lotto. (1) "Three Apparently New Mealy Bugs from Kenya", *Trans. R. Ent. Soc.* (in press); (2) "Some Diaspidini from Kenya" (in preparation); (3) "Three New Coccids Attacking Coffee in East Africa" (in preparation).

Visitors

Among the visitors to the Laboratories from abroad were Professor A. Fantoli, Rome; Mr. S. T. Hoyle, Nyasaland; and Mr. R. Van den Bosch, California.

Acknowledgments

I wish to acknowledge the good work of all the European and African members of the section. A high standard of work was maintained, despite their additional Emergency duties. The Field staff of the department continued to assist the work of this section and we are most grateful to them. Once again the essential assistance of the Commonwealth Institute of Entomology is acknowledged with pleasure.

ANNUAL REPORT OF THE SENIOR RESEARCH OFFICER (PLANT PATHOLOGY), 1953

A major change in the organization of the Plant Pathology service of the Department is the transfer of the work on wheat stem rust and advisory and research work generally on cereal diseases to the direction of the Senior Research Officer (Plant Breeding) at Njoro. A plant pathologist appointed to the Scott Laboratory in 1952 has been posted to the Plant Breeding Station.

Advisory Work

Four hundred and five specimens of plant disease material were received at the laboratory during the year. This is a decrease of 184 on the previous year and may be attributed in part to the prevailing drought in many areas, the Emergency and the appointment of a pathologist to the Forest Department and to the Plant Breeding Station. Fifty-five visits from the public were made to the section.

LEGUME INOCULANTS

A total of 231 cultures of legume inoculants was issued during the year, a decrease of 43 on the previous year.

PHYSIOLOGIC FORMS OF WHEAT STEM RUST

This work at the Scott Laboratory has been discontinued. It will henceforth be included in the reports of the Senior Research Officer (Plant Breeding) with a report of the situation as regards cereal diseases.

MYCOLOGICAL HERBARIUM AND PLANT DISEASE SURVEY

During the year 85 specimens were added to the Mycological Herbarium. Sixty-four specimens were sent to the Commonwealth Mycological Institute for determination. The Institute identified 79 specimens and cultures, including some sent during the previous year.

The following were the determinations received:—

Aecidium englerianum on *Clematis grata*, *A. garckeianum* on *Hibiscus cannabinus*, *A. hoffmannii* on *Conyza newii*, *A. macowanianum* on *Conyza volkenzii*, *A. schweinfurthii* on *Acacia hebecadoides*; *Alternaria brassicae* on *Brassica campestris* var., *A. citri* on *Citrus limon*, *A. crassa* on *Datura stramonium*, *A. zinniae* on *Zinnia elegans*; *Aspergillus flavus* and *A. tamarii* on *Triticum vulgare* (grain); *Botryosphaera ribes* on *Fuchsia hybrid*; *Cercospora concors* on *Solanum tuberosum* and *C. insulana* on *Limonium sinuatum*; *Corynelia uberata* on *Podocarpus gracilior* (seed); *Curvularia pallescens* on *Dactyloctenium aegyptium*; *Gloeosporium musarum* on *Musa sapientum*; *Glomerella cingulata* on *Carthamus tinctorius*; *Helminthosporium sativum* on *Hordeum vulgare* and *Triticum vulgare*, *Heterosporium echinulatum* on *Dianthus caryophyllus* and *H. tropaeoli* on *Tropaeolum majus*; *Melampsora euphorbiae* on *Euphorbia heterophylla* and *M. junodii* on *Vernonia dummeri*; *Penicillium corylophilum* on *Thea sinensis* and

P. vermiculatum on *Ananas comosus* (fruit); *Phleospora mori* on *Morus* sp.; *Phyllachora cynodontis* on *Cynodon* sp.; *P. digitariae* on *Digitaria* sp.; *P. eragrostidis* on *Eragrostis braunii*, *P. tricholaenae* on *Rhynchelytrum repens* and *Phyllachora sanguineolenta* on *Brachiaria brizantha*; *Puccinia aurata* on *Conyza pyrrhopappa*, *P. cesatii* on *Capillipedium parviflorum*, *P. (?) cucumeris* on *Coccinia grandis*, *P. cynodontis* on *Cynodon plectostachyum*, *P. elgonensis* on *Setaria holstii*, *P. erythraënsis* on *Andropogon schinzii*, *Puccinia graminis* on *Festuca pratensis*, *P. granularis* on *Pelargonium fischeri*, *P. guizotae* on *Guizotia scabra*, *P. penniseti* on *Pennisetum stramineum*, *P. polygoni-amphibii* on *Polygonum convolvulus*, *P. pruni-spinosae* on *Prunus domestica* and *Puccinia triticea* on *Triticum vulgare*; *Pyrenophora teres* on *Hordeum vulgare*; *Septoria apii* on *Pisum sativum*, *S. apii-graveolentis* on *Apium graveolens*, *S. chrysanthemi* on *Chrysanthemum* (Cult.), *S. dianthi* on *Dianthus caryophyllus*, *S. ebuli* on *Sambucus* sp., *S. helianthi* on *Helianthus annuus*, *S. lactucae* on *Lactuca sativa*, *S. lycopersicae* on *Lycopersicum esculentum*, *S. melanopsis* on *Vitis vinifera*, *S. meliae* on *Melia azedarach*, *S. nodorum* on *Triticum vulgare*, *S. petroselinii* on *Petroselinum hortense* and *Septoria tritici* on *Triticum vulgare*; *Taphrina deformans* on *Prunus persica*; *Tilletia foetida* on *Triticum vulgare*; *Uredo (?) behenickiana* on *Laeliocattleya* hybrid; *Uromyces albucae* on *Albuca* sp., *U. eragrostidis* on *Cypholepis jemenica* and *Eragrostis caespitosa*, *U. fabae* on *Vicia faba*, *U. leptochloae* on *Leptochloa obtusiflora*, *U. leptodermus* on *Brachiaria dictyoneura* and *Panicum maximum* and *Uromyces linearis* on *Panicum coloratum*.

Specific names of the following collections are not yet available:—

Phyllachora sp. on *Setaria aurea*, *Septoria* spp. on *Coleus* sp. and *Rumex* sp., and *Synchytrium* sp. on *Rhynchosia* sp.

The diseases and fungi which have been sent to the laboratory on grass and fodder crops, fruit and vegetables do not constitute any new records and are much the same as the previous year. Opportunity was taken of making a study of some diseases of *Hibiscus* in experimental plots throughout the Colony. Canker caused by *Botrytis cinerea* occurred on indigenous and exotic varieties of *H. cannabinus*. The variety Egyptian Teal, as in the previous year, being the most severely attacked. *Glomerella cingulata* caused canker on about two per cent of the Florida Strain at the Scott Laboratory. In 1952 the disease was confined to the Cuba variety. Seed saved from this was treated with Agrosan and was only slightly affected late in the season. The Florida seed was not dressed and suffered from early, apparently seed borne, infections. The disease was controlled by pruning and spraying with Perenox. A number of basal cankers on various varieties was caused by *Fusarium* sp., and in one instance by *Sclerotinia sclerotiorum* on a variety from Nigeria. No leaf infection of rust *Aecidium garckeianum* was noted but a single long stem canker occurred. All plants were heavily infected with *Oidium*. *Malva verticillata* was attacked by *Puccinia malvacearum*.

New or interesting records are as follows: *Dimorphotheca* and *Linaria* in the same locality were attacked by *Sclerotinia minor*, which also caused a root and crown rot of pyrethrum. A collar rot of *Fuchsia* was in two instances caused by *Botryosphaeria ribis*. A small plot of *Solanum andigenum* showed a heavy infection of *Cercospora concors*. *Geranium*, grown for essential oil, was attacked by *Phomopsis*, causing a basal stem canker, and by *Armillaria mellea* in various localities. *Rhizoctonia solani* caused a crown rot of *Pyrethrum* plants. *Solanum aculeastrum*, grown as a hedge plant, was affected by a severe die back associated with *Colletotrichum lycopersici*. *Gloeosporium musarum* was isolated from collapsed pseudostems of banana. *Armillaria mellea* attacked scattered plants in a

large plantation. A basal canker and severe die back of *Youngberry* was caused by *Coniothecium fukelii*. *Pythium* sp. was responsible for loss of seedlings of *Alysicarpus glumaceus* and *Vigna gracilis* in experimental plots.

MISCELLANEOUS

A semi-wild tomato growing at the Coast and alleged to be resistant to *Phytophthora infestans* was inoculated with the commonly recurring Blight strain. No difference in susceptibility was found between this and commercial varieties of tomato.

Cans of tomato purée from a canning factory were examined for sterility. Scum on dam water was examined for the Chemical Section and found to consist of a green alga, *Eudorina*. Larvæ of the Rhinoceros Beetle (*Oryctes monoceros*) from the Coast were attacked by *Metarrhizium anisopliæ*.

Specimens of the teleuto stage of *Puccinia polysora* were sent to pathologists in Southern Rhodesia, Nigeria and Tanganyika. A culture of *Ramularia bellunensis* was sent to a worker in Belgium.

Legume Inoculants

The distribution of cultures of legume nodule bacteria was continued and placed on a revenue-earning basis. A standard charge is made of Sh. 1 for each unit sufficient to treat 20 lb. of small seed. Cultures are on agar medium in tubes and bottles. The following amounts in units to treat 20 lb. were issued: Lucerne, 655; Serradella, 89; Clover, 64, Lupin, 99; Subterranean Clover, 37; Sunn Hemp, 56; Huban and Sweet Clovers, 10; Soya Bean, 10; Sainfoin, 11; Pea, 6; Teramnus, 4; Cowpea, 4; Alysicarpus, 5; Glycine javanica, 3; Phaseolus, 3; Vetch, 1. The majority of the strains are from isolations from local plants. Isolations of local strains from pasture legumes accompanied distribution of seed from the Pasture Research Station to workers in Australia.

Routine tests for the nodulating power, and nitrogen fixing efficiency of the stock cultures were continued throughout the year. In view of the inconsistent results with seedlings on agar a technique using freshly prepared vermiculite has been adopted. The seeds are sterilized, inoculated with the test culture and planted in small sterile pots of vermiculite and watered with a non-nitrogenous culture solution. For general growth and observation of the root system the vermiculite has proved to be superior to sand.

Reserve stocks of the principal strains are maintained on living plants of the appropriate species and re-isolated from time to time as required. Several new strains were isolated during the year. Of these, two proved to be exceptionally good strains, one from Subterranean Clover and one from a local species of Red Clover, probably *Trifolium ruppellianum*. A culture for White Clover was obtained from England which gave a better type of nodulation than those hitherto being distributed. Cross testing of various Clover strains has been done and tests made of stock cultures on certain indigenous legumes, the affinities of which are uncertain. Culture No. 15 from *Crotalaria incana* gave good nodulation of *Dolichos falcatus*, *Teramnus uncinatum*, and *Rhynchosia minima*.

PASSION FRUIT

Following representations from the Passion Fruit Board, some experimental work on "Brown Spot", *Alternaria passifloræ* was started, although the general aspects of control and etiology are well known.

A small plot has been established following the usual commercial practice to demonstrate systems of pruning and training and their effect on the incidence of "Brown Spot". The plot is also intended to provide material for the demonstration of fungicidal treatments.

Observations have been made on the progress of inoculations from cultures of plants growing in a glasshouse. Successful inoculations with spore suspensions have been made on leaves and growing plants, but stem lesions have only occurred when the fungus from a leaf inoculation has grown down the petiole. Three classes of leaf infection have been recognized, (1) lesions on the margins or between the main veins. This type has no serious effect on the leaf for three to four weeks; thereafter yellowing and premature abscission occurs; (2) on the main veins or encroaching into the main veins. If only one of the three main veins is infected rapid yellowing and abscission occurs. Mechanical damage and removal of sections of the main vein produced no comparable effect to that of the fungus. The possible effect of toxins is being investigated. It would appear that on a plantation one lesion on a main vein is enough to produce defoliation; (3) petiole infection. This form spreads slowly without fall of the leaf, presumably because the formation of the abscission layer is prevented. There is thus no barrier to the fungus continuing into the stem and there forming a canker. Direct inoculations into the stem have failed.

The production of conidia of *Alternaria passifloræ* in quantity was achieved by planting pieces of agar culture on to plates of water agar.

BLIGHT RESISTANT POTATOES

During the year ten lines were received from the Scottish Society for Plant Breeding through Dr. Black. The blight reactions of these are not known. No blight appeared on the susceptible control plants when the introductions were grown for the first time at the Scott Laboratory. Of the 12 varieties received in 1952 11 were grown for the second time at the Scott Laboratory and at two high altitude stations. Two of these were attacked by blight but the strain was not determined. With storage giving the tubers access to sufficient light it has been possible to keep seed potatoes from one long rains season to the next at Nairobi. During the nine to ten months' storage all the eyes develop but the thick sprouts do not exceed a little over one inch in length.

PYRETHRUM BUD DISEASE

Studies of the Pyrethrum Bud Disease have been continued. With the inoculation technique referred to in the previous report, a number of clones, which had been selected for resistance to *Ramularia* in the field, were tested. However, none of these clones differed appreciably from similarly treated known susceptible plants.

Construction is now almost completed of an air-conditioned cabinet with temperature and humidity control of a range from approximately 0° C. and 100° R.H. respectively. The cabinet will be used for various studies of the fungus, for the proving of plants which are being bred for *Ramularia* resistance and for the testing of fungicidal treatments.

Further observations have been made on the rate of development of the pyrethrum bud in relation to infection by *Ramularia*. The saprophytic growth of *Ramularia* on various substrata is slow and is at first a non-mycelial type sporulating within two or three days. After four weeks at room temperature growths

from a single conidia are no more than 3-4 mm. in diameter, pulverulent and more or less spherical. Observations of the early stages of infections both in the field and inoculations in the laboratory show that penetration of the bud is unlikely to occur at any point other than the bracts. There is no evidence to suggest that penetration of the bud takes place at the base of the receptacle or apex of the flower stalk. The period of growth of the normal bud from first appearance to the opening of the flower is about six weeks. During this period the bud increases in size from pinhead to 9-10 mm. in diameter and the stalk in length, according to its position, from about 1 mm. to 15-30 cms.

The rate of colonization of the bud tissue by the fungus appears to correspond to the rate of growth in culture. The length of time between inoculation and the appearance of disease symptoms is from three to four weeks, by which time the discoloration of the bracts can be seen. At this stage the fungus has not penetrated to the receptacle and the top of the stalk so that during this period, growth and development proceed as with a healthy bud. Further development is prevented only when the receptacle or apex of the stem is reached. It is a matter of observation that the majority of the typical diseased buds are in an advanced state of development with stems only slightly or no shorter than the rest of the clump.

In view of the length of time taken for the fungus to affect the growth of the bud, it can be assumed that it is unlikely that any dead bud less than about 4 mm. in diameter has been killed by *Ramularia*. If the bud becomes infected as soon as it is exposed, no interference with growth will take place until the bud is not less than half grown.

Observations on a number of buds show that some 10 per cent fail to develop. This results in the growth of both bud and stalk being arrested, giving a "pinhead" on a short stalk. Although *Ramularia* may occasionally be found on dead pinheads it is likely to be a chance saprophytic infection.

What might be termed a "false bud disease" sometimes affects the older buds. No *Ramularia* can be found on these buds. The bracts are usually lighter in colour and the neck is withered and curved into a semblance of a "shepherd's crook" whereas in true bud disease the neck is not withered and the bud is bent over at a sharp angle which suggests a "hanged man" rather than a crook.

In assessing the degree of disease in field experimental work it follows that for accuracy, detailed examination of individual buds is required and unless sporodochia are present on the outside of the bracts it is necessary to peel back and examine the inner surface with a lens for certain diagnosis.

Seed Testing Laboratory

The number of samples received for testing during the year was 1,000, a decrease of 139 on the previous year. The number was made up as follows: Cereals, 339; Grasses, 316; Vegetables, 103; Clovers and Legumes, 67; Fibre Crops, 9; Other Crops, 147; Ornamentals, 5; and Miscellaneous, 14. As from 1st January a charge has been made for seed testing varying with the type of seed and nature of the test required. For tests made for a farmer for his own information and on seed which he himself intends to sow a flat rate of Sh. 1 is charged.

Thirty plant species were added to the economic herbarium and a number of seed samples of flower and weeds, both indigenous and exotic, were added to the reference collection. Seventy-two specimens of weeds and crop plants were named for the public and officers of the Department.

The series of germination tests of the following indigenous grasses, *Bothriochloa insculpta*, *Cenchrus ciliaris*, *Eragrostis superba*, and *Panicum maximum*, from experimental plots at Machakos were continued. The interval between tests of the stored seed has now reached 18 months. The tests showed no increase in germination over the 12-month period. Molasses grass and Rhodes grass from the Kitale area need a six months' maturation period before adequate germination is attained. With most samples the highest germination occurred between 40 and 60 days after harvesting whereas with fully matured seed the highest germination occurred in the first two or three weeks. Difficulty with the germination of indigenous grass in the laboratory, especially *Setaria*, *Cynodon* and *Eragrostis* is still being experienced. These grasses are in every instance found to germinate better in soil than on filter paper. Little success has followed the conventional treatments.

Germination tests on pyrethrum seed picked at different stages of maturity were done to determine the optimum stage for collection. Green but fully formed seed gave about half the germination of seed about to be shed naturally, i.e. fully mature. A number of samples of pyrethrum seed consisted of a high proportion of unfertilized achenes.

The varieties of the more promising species of *Hibiscus* grown for observation in 1952 were grown as a long rains crop at the Scott Laboratory for collection and distribution of seed. Further plots were planted in the short rains in November.

A series of germination tests on oil seeds, tea and beans, following fumigation with Methyl bromide were done on behalf of the Entomological Section. The seeds tested were Linseed, Colza, Sunflower, Groundnuts, Castor, Niger and Cotton. The seeds were planted two hours after fumigation and thereafter at intervals of 24 hours and two weeks.

The fumigation appeared to have no effect on the germination of Beans, Sunflower and Cotton. Linseed showed a decrease in germination when planted two hours after fumigation, but did not differ from the control after two weeks' exposure to the air. Groundnuts and Castor seed were slower to germinate than the unfumigated seed, while the effect of fumigation on Colza was a slight increase in germination. In tea, there was no difference in germination between the control and seed kept for two hours before planting but thereafter germination decreased. Seed kept for one week and two weeks after treatment failed to germinate. Where vermiculite was used instead of sand germination of the fumigated seed after two hours was much reduced whereas the untreated seed in vermiculite germinated normally.

Germinations tests of Tomato seed treated with acetic acid showed only 3 per cent as against 82 per cent after 21 days for untreated seed. Hot water treatment of 54° C. for half an hour did not affect germination.

Tests were also done for the Entomological Section on Coffee seed fumigated with Hydrogen cyanide and Methyl bromide. The seed was germinated on sand at room temperature, fluctuating day and night and between filter paper at a constant temperature of 25° C. Untreated seed on sand at room temperature gave a germination of 32 per cent in 84 days and on filter paper at 25° C. no germination. Seed fumigated with H.C.N. and exposed for three days and seven days gave a germination of 16 per cent after 84 days at room temperature on sand, and at constant temperature on filter paper 0.5 per cent and 42 per cent germination respectively. In the latter treatment 41.5 per cent germinated after 90 days and at the constant temperature of 25° C., 6 per cent and 75.5 per cent

respectively, the latter figure being reached after 60 days. With the unfumigated seed, room temperature gave a germination of 42.5 per cent in 110 days and at a constant 25° C. a germination of only 2.0 per cent over the same period. From the above it is shown that, after a suitable interval for the fumigant to disperse, a constant temperature after fumigation has a beneficial effect on germination.

Special attention has been paid to the occurrence of seed-borne diseases and other fungi during the laboratory tests. The following determinations have been made by the Plant Pathological Laboratory.

Ungerminated seed of barley, oats, wheat, maize and sorghum produced growths of the following fungi: *Alternaria tenuis*, *Tricothecium roseum*, *Trichurus gorgonifer*, *Rhizopus stolonifer*, *Aspergillus tamarii*, *Aspergillus flavus*, *Aspergillus melleus*, *Penicillium* sp., *Chaetium* sp., *Phoma* sp. One sample of maize showed severe pink ear rot (*Fusarium graminearum*). Two samples of wheat with shrivelled grain were heavily infected with *Puccinia glumarum*. Four samples of *Brachiaria brizantha* contained several ergots. Apothecia were obtained when these "germinated" in sand. The *Sphacelia* stage was also present. A *B. soluta* sample had a few ergots and a heavy infection of *Sphacelia* and *Cerebella*. Eight samples of *Bothriochloa insculpta* were infected with *Sphacelia* and *Cerebella*, as were samples of *Cenchrus ciliaris*. Traces of *Fusarium* were present in all samples. *Melinis minutiflora* and *Panicum maximum* samples were also infected with *Ergot*, *Sphacelia* and *Cerebella*. Samples of imported seed of *Paspalum dilatatum* from South Africa had a heavy attack of *Claviceps paspali*.

ANNUAL REPORT OF THE SOIL CHEMIST, 1953

FERTILIZER STUDIES

Work in parts of Nyanza Province has shown that in certain areas consistent and economic responses to fertilizers were obtained. Cereals in a densely populated area on Kavirondian sedimentary and Nyanzian volcanic rocks, mainly in the southern locations of North Nyanza, were found consistently and markedly to respond to phosphatic fertilizers having a high early availability. In another area of soils mainly derived from basement complex rocks, centred on Kimilili, similar marked and consistent responses have been obtained both to phosphates and sulphate of ammonia. Preparations have therefore been made for the introduction of the use of fertilizers into African agriculture in these areas, the first step being a large number of demonstration plots using 18 per cent granular single superphosphate in the southern locations and the same fertilizer together with sulphate of ammonia in the northern area.

The fertilizer experiment programme for 1953, aimed mainly to continue longer term fertilizer investigations initiated in 1952, and to obtain further data on fertilizer responses in areas where exploratory work had shown fertilizers to be beneficial. Exploratory work in 1953 was confined to the laying down of single replicates of "two cubed" factorial N.P.F.Y.M. trials at ten sites in Central Nyanza and North Nyanza in areas which had not previously been fully investigated. Of these trials, trials at three sites on pallid sandy soils of granite origin and at three sites on pallid loams over murram of Kavirondian sediment derivation were carried through to successful completion. The following table presents meaned data on the fertilizer effects recorded on these two soils:—

Effect	Granite Soil Sites	Kavirondian Sediment Sites	
	<i>Maize</i> Bags per acre	<i>Maize</i> Bags per acre	<i>Sorghum</i> Bags per acre
General Mean	19.42	7.10	5.08
M. (manure at 5 tons per acre)	-0.43	+1.25	+0.15
P. (40 per cent supers at 1 cwt. per acre)	+0.31	+1.23	-0.38
M.P.	+0.44	+1.35	-0.55
N. (sulphate of ammonia at 1 cwt. per acre)	+0.55	+1.20	+0.06
M.N.	+0.04	+0.68	+0.58
P.N.	-0.49	+0.53	+0.04
M.P.N.	-0.39	-0.33	+0.48
Magnitude of smallest signifi- cant effect (P. = 5 per cent)	1.09	2.06	1.16

Despite a considerable site to site variation on the Kavirondian sediments which severely reduced the significance of the results, maize showed promise of responding to all the treatments applied, and to respond best to the treatments in combination. The soils concerned are poor and so the results are in line with expectation: sorghum on the same soils was much less responsive to fertilizer application. The granite soils yielded well even without fertilizers and no benefit was apparent from their use on them: observations made during these trials led to the conclusion that here improvement in cultural methods was of dominant importance in improving crop performance.

Results of trials in North Nyanza in 1952 led to suggestions that African crops might respond satisfactorily to fertilizers at levels of application which are somewhat lower than those commonly used in cereals production. In a trial designed to test this suggestion, however, 0.48 cwt. per acre of double-supers and of sulphate of ammonia were the lowest rates of application of these fertilizers which produced measurable effects on crop yields. Elsewhere the more elaborate trials involving sulphate of ammonia, 40 per cent super-phosphate and muriate of potash at three levels in factorial combination which were started in 1952 were continued in 1953. The residual effects anticipated on soils which had shown pronounced primary effects in 1952, materialized only in an isolated case of leaf colour differences immediately before harvest: no residual effects on growth or grain yield from the previous year's fertilizing were recorded. Where in these trials fertilizers were applied in 1953, fertilizer responses were again observed: weather conditions during these trials, however, were so inclement that the crops were near failures and the yield data obtained is unlikely to have economic significance. In view of the importance of phosphates in many soils in Kenya, the search renewed in 1952 for means of reducing the cost of phosphate application was continued and widened. The scope of these investigations was widened to include investigations into the application of super-phosphate in conjunction with organic manures, and in conjunction with phosphatic Guano as well as Uganda Rock Phosphate (investigations of which had been renewed during 1952).

Although simple liming trials have already been carried out in the Highlands it was decided to put down a series of more comprehensive liming experiments as a subsidiary to organic matter studies. Soil samples were taken and lime requirement figures obtained for these with the object of finding suitable sites. The neutralizing values and degree of fineness of several samples of liming materials were also estimated. The objects were to (1) apply a relatively small amount of lime so as to increase the amount of calcium as a nutrient; (2) to raise the pH to a point approaching neutrality; and (3) to compare different liming materials. Phosphate, potash and nitrogen treatments were also included. The first season's results from these trials are not yet available.

SOIL FERTILITY STUDIES IN THE KENYA HIGHLANDS

Because of the priority accorded to soil organic matter studies in this investigation a preliminary survey was made by Professor Stelly of selected farms, and soil samples were taken from neighbouring fields of grassland, arable land and virgin land with the object of investigating the chemical changes brought about by cultivation and of choosing suitable sites for field organic matter studies. Ninety samples of soil (0-8 in. depth) were collected and organic carbon, total nitrogen and soil reaction determinations were carried out.

Organic carbon was estimated on all samples, by the Walkley Black wet combustion method, and on 12 samples from one farm it was also determined by dry combustion. Taking the dry combustion results as absolute, the recovery of carbon by the wet combustion method varied from 75 per cent to 85 per cent with a mean value of 78 per cent.

Both carbon and nitrogen varied considerably between localities and between fields on any one farm. The C/N ratio also varied between localities, but except at one centre the ratio was similar for cultivated and uncultivated fields on any one farm. Extreme values for carbon were 1.41 and 4.31 per cent with a mean of 2.81 per cent, and for total nitrogen 0.11 and 0.42 per cent with a mean of 0.24 per cent. The range of values obtained for the C/N ratio was—

Range of C/N Values	Number of Soils
8.5–9.4	7
9.5–10.4	9
10.5–11.4	17
11.5–12.4	23
13.5–14.4	8
14.4–15.4	1

There is an indication of a general drop in carbon and nitrogen when virgin land is cultivated and an increase in both when such cultivated land is put down to, or allowed to revert to grass. There is also evidence of a drop in soil reaction (pH) on cultivation and a rise when grass follows cultivation. Regional variations and the difficulty of making a simple classification of the samples precluded a general finding but individual figures are given below for three localities—

		<i>Marindas</i>	<i>Bahati</i>	<i>Kitale</i>
Virgin land	C	4.31	3.25	2.02
	N	0.32	0.26	0.16
	C/N	13.5	12.5	12.6
	pH	5.34	5.73	5.67
Cultivated 15–25 years	C	3.54	2.35	1.41
	N	0.30	0.19	0.11
	C/N	11.8	12.4	12.8
	pH	4.93	5.60	5.27
Cultivated land now under grass	C	3.45	2.72	1.67
	N	0.30	0.23	0.13
	C/N	11.5	11.8	12.8
	pH	5.10	5.71	5.55

While early breaking followed by fallowing had a marked effect on couch grass infestation on new arable land no measureable benefits to the first crop on such land were apparent from the practice. Forty per cent super-phosphate application perhaps associated with top dressings of nitrogenous fertilizer has been the most beneficial treatment yet applied experimentally to the first crop on newly broken land. Some evidence was obtained that sulphate of ammonia is beneficial to wheat on land into which a good quantity of stover from a previous cereal crop has been ploughed, particularly if on acid soil the application is associated with a good dressing of lime. Sulphate of ammonia was found to be most beneficial when applied in association with ploughing in May or earlier, and to be more beneficial if applied to May or earlier ploughed stubble than to June ploughed stubble: it was, however, of greatest benefit if applied to the crop direct rather than to the stubble before ploughing, these benefits being greatest if the stubble was ploughed in May or later!

In field trials undertaken to determine the relative effectiveness of five different common nitrogenous fertilizers, neither marked fertilizer effects nor marked differences between fertilizers were recorded. When heavy dressings of readily available nitrogenous fertilizers were given, however, lodging of grain was appreciably more severe.

In continuation of studies by Gethin Jones (*E.A.A.J.*, 8 (1942), 48) further examination had been initiated in 1951, into the fertility building effects of *Glycine Javanica* at Scott Agricultural Laboratories. Season to season changes in the organic matter of nitrogen accumulation and in the crumb aggregation effects of this crop received particular attention. Unfortunately, no soil samples were taken from the plots before planting the legume, but data obtained from one year after planting are summarized below:—

Sampling Details	Walkley and Black organic C%	N%	Crumb Aggregation	
			greater than $\frac{1}{2}$ mm.	less than $\frac{1}{2}$ mm. but coarser than "fine sand"
0-3"—				
Sept. 1952 ..	1.77	0.18	9.0	10.3
Mar. 1953 ..	1.99	0.14	17.7	14.9
Sept. 1953 ..	1.86	0.18	24.6	16.2
Least difference for significance:				
P = 5% ..	0.20	not determined	8.1	4.1
P = 1% ..	—		11.7	—
3-6"—				
Sept. 1952 ..	1.81	0.17	15.8	11.6
Mar. 1953 ..	1.96	0.14	22.9	15.6
Sept. 1953 ..	1.79	0.17	24.3	16.6
Least difference for significance:				
P = 5% ..	0.14	not determined	9.0	4.5
6-12"—				
Sept. 1952 ..	1.67	0.17	36.7	10.3
Mar. 1953 ..	1.86	0.17	42.8	15.7
Sept. 1953 ..	1.67	0.14	42.0	14.0
Least difference for significance:				
P = 5% ..	not significant	not determined	not significant	5.5

Whilst significant effects are apparent in the organic carbon status of the top 6 in. of soil under *Glycine Javanica* there is no indication of a continuous build-up of organic matter, the main feature of the data being the peak of accumulation in March, 1953. The long rains of 1953 were not well suited to *Glycine Javanica*; in consequence, the crop made poor growth and the contribution it could make then to soil organic matter was small: on this account oxidation of soil organic matter might well have out-paced accumulation during the period March/September, 1953, leading to the decline in the organic matter status recorded. The nitrogen data is even more erratic than the carbon data and were incomplete: no tests for significance were therefore undertaken. There was a marked aggregation of the soils under the *Glycine Javanica* into both coarse and fine crumbs between September, 1952, and March, 1953, the aggregates then formed being able to withstand the conditions which led to a decline in organic matter status in March and September, 1953.

While the structure improvement effects of *Glycine Javanica* demonstrated by Gethin Jones (*loc sit*) is thus supported by the data, no clear support has yet been obtained for the chemical fertility building effects of the crop which he reported. Continuation of this investigation to its completion should provide data on which more precise conclusions can be drawn regarding seasonal influences which as yet may be masking the beneficial effects which Gethin Jones demonstrated.

SOIL SURVEYS

The surveys in collaboration with the Soils Survey Division, E.A.A.F.R.O., initiated in 1952, were continued in 1953, and were extended to Nakuru district. Additionally, parts of Nairobi, Thika and Machakos districts have been mapped directly by the Soils Survey Division, E.A.A.F.R.O., particularly detailed mapping being undertaken on the East African Research Station at Maguga and the Coffee Research Station at Jacaranda. Again, reconnaissance surveys, particularly in connexion with settlement and development schemes, were undertaken in Embu, Meru, Kipini, Lamu and West Suk districts. Meanwhile, field officers, particularly in Rift Valley districts, undertook the production of first attempt soil maps of their districts using their local field knowledge as the basis on which they worked: these maps are being checked and guidance is being given regarding their improvement wherever opportunities occur.

NITROGEN STUDIES

Determination of the ammonia nitrogen content of rain water collected at Scott Agricultural Laboratories was continued, the results from daily collection being:—

RAINFALL

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rain, Inches	0.86	Nil	2.08	5.13	7.07	0.69	0.60	1.14	1.56	1.92	5.73	1.22
Ammoniacal N added By Rain: lb./acre ..	0.122	Nil	.307	.162	.837	.025	.032	.076	.038	.041	.321	.061

Mean addition of Ammoniacal N in lb. per acre per 1 in. rainfall=0.072.

The mean addition of Ammoniacal N in lb. per acre per 1 in. rainfall again falls within the range observed from 1950 to 1952. The following table sets out for comparison the mean addition of Ammoniacal N in lb. per acre per 1 in. rainfall at S.A.L. month by month during the years 1950 to 1953:—

Month	1950	1951	1952	1953
January	.059	.125	—	.154
February	.040	.139	.118	—
March	.065	.148	.156	.148
April	.057	.079	.048	.032
May	.055	.065	.060	.118
June	.036	.043	—	.029
July	.031	.103	—	.054
August	.123	.131	.039	.079
September	.105	.229	.114	.024
October	.095	.058	.166	.021
November	.050	.221	.067	.056
December	.023	.092	.130	.050

The 1953 rate of addition was notably higher before the long rains season than afterwards.

PINEAPPLE STUDIES

In a trial in the Thika area undertaken by the Horticultural Section of this Department, massive dressings of sulphate of ammonia were found to lead to very great improvements in growth and productivity of pineapples. The soil on which the trial was carried out and on which a considerable proportion of the pineapples in Thika are grown has somewhat low chemical fertility reserves: accordingly, an investigation was undertaken of the effect of the various treatments in this trial on base status. The trial was laid out in four replicates of an unconfounded 2⁴ factorial trial involving the factors Mg (= 5 foliar sprayings of 2 per cent MgSO₄ at monthly intervals) vs. nil, N (= 4 dressings each of 500 lb. per acre at bi-monthly intervals) vs. nil, Fe (= 5 foliar sprayings of 2 per cent FeSO₄ at monthly intervals) vs. nil, and D (= soil fumigation 10 per cent Ethylene Dibromide in one application) vs. nil. One soil sample was collected for analysis from each of the 64 plots which made up the trial: the samples were collected from soil permeated with roots at sites between pineapple plants. On each sample determinations of pH with a glass electrode, of total exchangeable bases and exchangeable hydrogen by Brown's method (*Soil Science*, 56 (1943), 353) and of the per cent saturation of the base exchange complex were undertaken. The effects of the various treatments on the measured soil characteristics were examined towards the close of the first harvest season.

The following table summarizes the mean effects of the various treatment combinations on the chemical property measured:—

	pH	Exchangeable Hydrogen ME %	T.E.B. ME %	% Saturation of Exchange Complex
General mean ..	5.55	3.23	7.31	69.93
Treatment effect				
Mg	-0.05	-0.02	+0.30	+0.60
N	-0.81*	+1.04*	-0.77†	-9.27*
MgN	-0.02	-0.31	-0.24	+1.47
Fe	+0.07	-0.48	-0.20	+2.07
MgFe	+0.06	-0.07	-0.40	-1.25
NFe	+0.05	-0.24	+0.22	+1.46
MgNFe	+0.06	-0.54†	+0.02	+2.90
D	+0.07	+0.37	+0.07	-2.80
MgD	+0.02	-0.15	+0.04	+0.32
ND	-0.09	-0.18	+0.17	+1.85
MgND	+0.02	-0.09	-0.43	-1.12
FeD	+0.08	+0.01	-0.03	-0.32
MgFeD	-0.02	+0.30	-0.20	-2.37
NFeD	+0.14	+0.06	-0.48	-1.66
MgNFeD	0	+0.20	+0.19	-1.11
Minimum treatment effect for significance:				
P = 5% ..	0.15	0.50	0.68	4.24
P = 0.1% ..	0.25	0.88	—	7.45

* Significant at P = 0.1% † Significant at P = 5%

The sulphate of ammonia treatment profoundly and highly significantly increased the acidity and led to an equally important depletion of bases from the soil near to the plant on which the fertilizer had been applied. In view of the importance of the effect of sulphate of ammonia on base status, yield data from the trial was examined with a view to determining the extent to which soil base status influences pineapple productivity. The table below presents data relating to soil pH at harvest time and the average weight of the fruits harvested, the data being grouped according as the plots had or had not received dressings of sulphate of ammonia:—

pH	With Sulphate of Ammonia <i>Average weight of fruit in ozs. per fruit</i>	pH	Without Sulphate of Ammonia <i>Average weight of fruit in ozs. per fruit</i>
4.66	66	5.54	49
4.68	71	5.58	62
4.70	64	5.66	61
4.78	54	5.70	52
4.79	64	5.70	54
4.80	92	5.73	59
4.83	62	5.77	54
4.84	59	5.79	58
4.85	63	5.81	52
4.89	66	5.81	57
4.90	66	5.86	55
4.92	65	5.87	42
4.99	64	5.88	51
5.08	64	5.90	54
5.13	59	5.92	54
5.15	70	5.93	52
5.17	67	5.97	44
5.20	65	6.01	53
5.23	63	6.02	52
5.24	62	6.03	53
5.24	64	6.03	57
5.27	60	6.04	53
5.27	66	6.05	58
5.28	64	6.06	56
5.40	66	6.06	57
5.43	58	6.07	52
5.44	58	6.11	37
5.52	63	6.12	51
5.52	76	6.18	65
5.62	76	6.20	52
5.86	67	6.46	52
5.86	77	6.61	49
$r = -0.013$		$r = -0.212$	

No significant correlation was found between pH and fruit weight either in the presence or absence of sulphate of ammonia dressings. There is therefore no indication that base depletion through applications of sulphate of ammonia

is likely adversely to affect pineapple yields at least until soil pH falls below 4.7. Cultivation between cycles will mix fertilized with unfertilized soils. In consequence the base depletion effects of sulphate of ammonia applications will be greatly diluted. On this account there is every indication that provided the land is thoroughly cultivated between cycles, the beneficial effects of heavy dressings of sulphate of ammonia are likely to continue over a number of cropping cycles. Confirmation of these conclusions is, however, needed, and is intended to be sought when the trial area examined is cultivated on conclusion of the present cycle and during subsequent cycles if the experiment as at present designed is continued.

KIKUYU BRACKEN SOIL STUDIES

During 1953, the Agricultural Department was much concerned with the formulation of schemes for agricultural development in African areas. Deliberations on this matter were concerned both with increasing productivity of already closely occupied lands and with treatment of presently sparsely occupied areas with a view to their utilization for the absorption of surplus population from overcrowded areas. Of these areas, part of Central Province, totalling some 300 square miles along the lower fringes of the Aberdare and Mount Kenya forests, presents special opportunities for contributing to the relief of population pressure elsewhere in that Province. Its fertility under existing cultural practices is, however, low for general farm crops, its soils being extremely acid and deficient in forms of calcium, phosphorus and nitrogen which are usable by plants while exchangeable aluminium and exchangeable manganese contents reach levels of toxicity. At the same time, the soils are relatively abundantly supplied with organic matter and with incompletely decomposed nitrogenous compounds and are adequately supplied with available potassium and magnesium. The low nitrogen availability has been attributed to low soil biological activity. The soils are deep and very freely drained and have a loose, floury structure. Indigenous vegetation is forest, but regeneration after cropping is to a dense mass of bracken. Despite a good rainfall, the crops obtained are poor and the density of population supported is small.

Work in earlier years had suggested that additional available nitrogen and phosphorus were essential for satisfactory crop growth and that plant nitrogen requirements could be supplied by the acceleration of the decomposition of nitrogenous matter in the soil through increasing biological activity there by application of lime. To test these suggestions, to seek further information on the factors involved in the low fertility of these soils and to provide a basis for field trials aimed at raising their productivity, a programme of greenhouse experiments and associated laboratory studies have been initiated. The soil on which the studies are being undertaken originated from Kianjakoma, Embu district. During 1953, investigations were aimed primarily at determining the extent to which liming and phosphating were beneficial and the extent to which any benefits arising from liming could actually be attributed to acceleration of nitrate nitrogen release rather than to other causes. For these investigations gross samples of the soil were intimately mixed with slaked laboratory reagent grade calcium oxide in quantities which previously determined titration curves had indicated to be sufficient to raise the pH to 6.5. The limed soils were incubated between 20 and 25°C. and between 15 and 20 per cent moisture content for periods of up to 12 weeks, periodic nitrate and ammoniacal nitrogen determinations being carried out on representative samples of the soil. These determinations suggested a rate of nitrate nitrogen accumulation of about 5 ppm. N per week under the incubation conditions adopted: there was little ammoniacal N accumulation during the period of sampling.

Unlimed soil, newly limed soil, soil which had been incubated with lime for six weeks and soil which had been incubated with lime for 12 weeks were utilized in a factorial trial on a greenhouse scale. The other factors examined were:—

- (1) Addition of sodium nitrate to raise the nitrate nitrogen content of the soil to 80 ppm. vs. no sodium nitrate added.
- (2) 100 ppm. 40 per cent super-phosphate added vs. no super-phosphate added.
- (3) Super-phosphate intimately mixed with the soil vs. super-phosphate placed in pockets in the soil near the planting holes.

The trial comprised a single replicate of 32 pots sub-divided into four blocks by suitable confounding. The pots were locally made earthenware flower pots, approximately 13 in. tall, 10 in. upper diameter and 5 in. lower diameter, painted internally with three coats of Sisson's grey bitumen solution, following the Long Ashton technique (*Commonwealth Horticultural Bureau Technical Communication* No. 22 (1953)). Sudan grass seedlings previously germinated on washed, sterile sand in the seed testing laboratory were planted in each pot until a stand of four established plants per pot was obtained. The pots were watered as required, leachates being collected and returned to the pots whence they came. No special measures were needed or taken to reduce atmospheric temperatures or to increase atmospheric humidity in the greenhouse. The Sudan grass in all limed pots grew away quickly, made normal growth and started to flower nine weeks after planting. The Sudan grass in the unlimed pots survived throughout the experiment but remained sickly and scarcely grew beyond the seedling stage. At ten weeks the plants in each pot were cut off at ground level, dried and weighed. Soil samples were also taken from each pot for laboratory investigation.

The following tables set out details of the effects of the more important treatment combinations on dry matter yields, together with a statement of the least differences between the various treatment effects required for significance:—

FIVE-WAY TABLE, N/LIME

	No N applied	N applied	N + No N Mean
No lime	0.12	0.80	0.46
Limed at planting	5.20	6.80	6.00
Lime + No lime (Mean) ..	2.66	3.80	3.23
Limed 6 weeks before planting ..	5.05	10.02	7.53
Lime + No lime (Mean) ..	2.58	5.41	4.00
Limed 12 weeks before planting ..	4.17	8.97	6.57
Lime + No lime (Mean) ..	2.14	4.88	3.51
General Mean	3.64	6.65	5.14

TWO-WAY TABLE, P/LIME

	No P applied	P applied	P + No P Mean
No lime	0.12	0.80	0.46
Limed at planting	3.80	8.20	6.00
Lime + No lime (Mean) ..	1.96	4.50	3.23
Limed 6 weeks before planting ..	2.47	12.60	7.53
Lime + No lime (Mean) ..	1.29	6.70	4.00
Limed 12 weeks before planting ..	3.17	9.97	6.57
Lime + No lime (Mean) ..	1.64	5.38	3.51
General Mean	2.39	7.89	5.14

TWO-WAY TABLE, P/N

				No P	P	Mean
No N	..	..	..	2.64	4.64	3.64
N	..	..	..	2.15	11.15	6.65
Mean	..	..	..	2.39	7.89	5.14

TWO-WAY TABLE, PHOSPHATE APPLICATION

				No P	P	Mean
P placed	..	..	..	(2.35)	8.21	5.28
P mixed	..	..	..	(2.48)	7.57	5.03
Mean	..	..	..	2.42	7.89	5.15

NOTE.—For all tables.

Mean differences for significance are:—

	P=	
	5%	1%
Within N/L and P/L combination	4.45	6.24
Within N/P and phosphate application combination and between means determining liming effects	3.14	4.41
Between means determining N and P effects	2.22	3.12

The striking effect of liming on the growth of the Sudan grass on this Kikuyu bracken soil is reflected in the highly significant and the greatly increased yields of dry matter from the limed pots, than from the unlimed pots. Differences between liming treatments, on the other hand, were small and insignificant. Additions of nitrate had a significantly beneficial effect on growth, but as the nitrate effect was not significantly influenced by liming, it is concluded that the added nitrate functioned directly as a plant nutrient and that the beneficial effect of liming is not attributable to accelerated liberation of forms of nitrogen which are directly assimilable by plants. Phosphates also had a pronounced beneficial effect, the effect being appreciably greater on limed than unlimed soil and when nitrate was added, than when no nitrate was added. Placed phosphate and mixed phosphate gave similar results; on this account it seems likely that the added phosphate also functioned primarily as a nutrient and did not operate through fixation of toxic concentrations of aluminium or manganese.

An incidental observation of considerable interest made during the trial was that Foxtail millet seed which must have been in the sample of soil received, germinated, made good growth and flowered normally even on unlimed Kikuyu bracken soil. This observation is in line with observations already made by field officers working in the Kikuyu bracken area that different crops exhibit widely different tolerances to local conditions there.

Though the investigations are still in a relatively early stage and are continuing the interim conclusion may be drawn that the liming of this soil to a pH around 6 (involving applications of about four tons per acre of burnt lime) will produce remarkable improvements in growth of some cereals, that for maximum

effect such liming needs to be associated with parallel nitrogenous and phosphate fertilizing and that the variation which exists in the tolerance of different grain crops to local conditions justifies continued trial of new introductions.

DETERMINATION OF MOISTURE IN MAIZE

In the East African territories disagreement has arisen over the moisture content of certain consignments of maize which were the subject of inter-territorial sales. It seemed probable that such disagreement arose owing to the use of different methods for determining the moisture content of maize at the different centres where the determinations were carried out. The determinations most widely used in East Africa are Brown-Duvel distillations and resistivity measurements using a Marconi Moisture Meter, but there is no record of either of these methods having been standardized on the basis of a two-stage oven drying method which had been proposed for general adoption as an absolute standard for use in the determination of moisture content of grain in the British Colonial Empire. This two-stage oven drying method consists essentially of conditioning a weighed sample of whole grain for 48 hours to laboratory atmosphere, re-weighing the sample after this time and grinding and determining the moisture content of an aliquot of the ground sample by oven drying for one hour at 130°C. In the first instance, investigation was aimed at determining the reproducibility of the Brown-Duvel, the Marconi Moisture Meter and the two-stage oven drying methods, and of comparing the results obtained by these several methods with one another. For this purpose, six bags of maize were conditioned to different moisture levels ranging from approximately 12-17 per cent moisture. Two samples of grain were drawn by probe from each bag, and the 12 samples of maize so obtained were stored in sealed Kilner jars. The moisture of the 12 samples were determined in triplicate by the three methods described, the means of the results obtained being given in the table below:—

TABLE I

<i>Bag and Sample</i>	Method of Determining Moisture			Differences Between Means	
	<i>Drying Oven 130°C. %</i>	<i>Brown- Duvel %</i>	<i>Marconi Meter %</i>	<i>Oven: Brown- Duvel %</i>	<i>Oven: Marconi %</i>
A1	13.51	11.73	13.44	+1.78	+0.07
A2	13.65	12.60	14.04	+1.05	-0.39
B1	12.65	11.96	13.70	+0.69	-1.05
B2	12.34	11.80	13.57	+0.54	-1.23
C1	14.86	14.64	15.47	+0.22	-0.61
C2	14.92	14.60	15.48	+0.32	-0.56
D1	13.60	13.90	14.68	-0.30	-1.08
D2	13.79	13.80	14.65	-0.01	-0.86
E1	16.31	16.03	16.96	+0.28	-0.65
E2	16.54	16.16	17.00	+0.38	-0.46
F1	16.01	15.93	17.00	+0.08	-0.99
F2	16.38	15.93	16.97	+0.45	-0.59

Difficulties were experienced in controlling the time and temperature in the two-stage oven drying method. In consequence the first experiment was repeated, using a modification of the oven drying stage of the two-stage oven drying tech-

nique aimed at obtaining better control over time and temperature during drying. The means of the results so obtained are given in the table below:—

TABLE II

<i>Bag</i>	Method of Determining Moisture			Differences Between Means	
	<i>Drying oven</i> 130C. %	<i>Brown-Duvel</i> %	<i>Marconi Meter</i> %	<i>Oven: Brown-Duvel</i> %	<i>Oven: Marconi</i> %
A	12.93	12.80	13.16	+0.13	-0.23
B	12.30	12.05	13.06	+0.25	-0.76
C	13.99	14.00	14.00	-0.01	-0.01
D	13.22	13.30	13.63	-0.08	-0.41
E	15.04	15.25	15.76	-0.21	-0.72
F	14.95	14.85	15.56	+0.10	-0.61

Finally, in order to determine the extent to which different manipulators at different centres might obtain different results from one another in carrying out Brown-Duvel and Marconi Moisture Meter determinations, six further samples of maize were taken and stored as before in sealed Kilner jars. Moisture determinations were performed on the six samples at these laboratories using all three methods described, and the remaining portion of each sample was sent in its Kilner jar to Mombasa for the Chief Grader and Inspector there to determine the moisture in each sample by the Brown-Duvel and the Marconi Moisture Meter methods. the results so obtained are given below:—

TABLE III—SCOTT LABORATORY MOISTURE RESULTS

<i>Bag</i>	Method of Determining Moisture				
	<i>Drying</i> 130°C. %	<i>Brown-Duvel</i> %		<i>Marconi Meter</i> %	
		<i>Nairobi</i>	<i>Mombasa</i>	<i>Nairobi</i>	<i>Mombasa</i>
A	11.8	11.7	10.5	12.9	13.2
B	11.3	11.5	jar broken in transit	13.0	jar broken in transit
C	13.4	13.6	13.0	14.9	15.0
D	13.7	13.7	12.9	14.8	15.2
E	15.0	15.0	14.4	16.4	16.6
F	14.7	15.2	14.4	16.5	16.8

From the results of this experiment it appears that:—

- There is agreement between the standard oven method and the Brown-Duvel method as performed at these laboratories.
- The Brown-Duvel results in Nairobi do not agree with the Brown-Duvel results in Mombasa.
- The Marconi Meter gives higher results than either the standard oven method or the Brown-Duvel method. The difference lies very close to the limit of 1.5 per cent error which has been proposed as the maximum permissible between different methods of moisture determination.
- The Marconi Meter gives results in Nairobi and Mombasa which agree within the limits of accuracy claimed for the meter.

The following are the main conclusions reached from this investigation:—

(1) The Brown-Duvel method as performed at these laboratories agrees with the standard two-stage oven method, but the results are possibly affected by large changes in the atmospheric pressure. Its operation is messy and great care must be taken over its operation and maintenance, *if* the results are to be consistently accurate. If the results are subject to variation with atmospheric pressure changes it does not seem a desirable method to employ in the East African territories unless all stations using it are at approximately the same atmospheric pressure.

(2) The Marconi Meter does not agree with the standard two-stage oven drying method, and the difference between the results is considerable. *However*, the meter cannot, under the present circumstances, be expected to agree with the oven method because the meter is calibrated against a four-hour drying period of 120°C.

(3) In view of its simplicity of operation and the reproducibility of results, and in order to standardize the moisture determinations on consignments of maize, it seems necessary that the Marconi Meter continue in use as an official method of measuring moisture in maize, *but*, in order to conform with the standard method, the Marconi firm should be approached to produce as soon as possible a calibrated scale based on the above-mentioned standard method.

COMPOSITION OF LOCAL PLANT PRODUCTS, FOODSTUFFS AND MANURES

The recording of the composition of local plant products, fertilizers, manures and foodstuffs was continued. The following analyses are of general interest:—

Plant Products and Foodstuffs

Material	Moisture %	Ash %	Crude Protein %	Ether Extract %	Crude Fibre %
Njahi seed ..			23.6		
Okra seed (1) ..	19.92	4.13	20.26	15.76	15.39
Kikuyu grass silage (2) ..	72.0		3.3		
Pods and beans of Acacia spiro- carpa (3) ..	10.8	5.6	16.0	1.1	18.3
Kapok cake ..			26.6		
Acacia bark (4) ..	11.5	10.3	4.6	0.9	23.4
Maize and lupin silage ..	75.0		2.3		
Veldt hay ..	8.8	7.6	6.4	1.6	32.7
"Ritter" hay (5) ..	76.5	2.5	1.5	0.2	
Velvet bean meal	9.48	3.63	13.45	3.26	17.49
Charlock seed press cake (6) ..	9.3	4.9	25.5	18.4	10.9

Notes:—

(1) Used as poultry food by poultry keepers in Mombasa area.

(2) The only sample of Kikuyu grass silage received at the laboratories.
Good feed.

(3) Relished by stock in dry weather in Tambach area.

(4) Greatly relished by cattle in the Kesikon-Esageri area.

(5) First "Ritter" process material received at the laboratories.

(6) Not recommended as a feed.

Manures and Fertilizers

	Moisture %	Organic Matter %	Nitrogen %	P ₂ O ₅ %	K ₂ O %	CaO %
Burnt cashew nut husk ..	6.7	—	0.2	1.5	2.4	
Napier grass com- post ..	73.9	16.3	0.5	0.1	1.2	
Grass and maize stem compost ..	70.0	19.8	0.48	0.57	0.91	
Papyrus grass compost ..	76.0	21.6	0.16	0.01	0.09	
Grass compost ..	70.0	23.1	0.45	0.08	0.47	
Boma manure ..	37.0	16.0	0.50	1.26	0.17	
Sisal waste ..	6.96	—	1.30	0.59	2.27	12.5
Bat guano ..	8.10-31.0	—	9.0-5.6	5.9-3.7		

WEED KILLERS

During 1953, hormone type weed killers for the first time found wide farm application in the control of broad leaved weeds in maize. The majority of farmers concerned observed un-anticipated and dramatic growth distortions in their maize soon after applying the weed killers and there was widespread apprehension that the crop would fail to develop and to form grain.

The leaves mainly affected were the two leaves which were just emerging at the time of spraying. The effect on them of the spray was to inhibit the normal opening of all but their tips but not their natural extension. The new leaves of the plant as they were produced, remained trapped by the elongated waisted envelope which was formed by these two most affected leaves and, in consequence, the upper parts of moderately severely affected plants developed a decidedly leek-like appearance. With increasing severity of the condition, there was increasing tightness of wrapping of the envelope while in less affected plants, the base of the envelope soon opened sufficiently to allow of normal emergence of the most recently formed leaves. On the other hand, in a few instances normal extension of the enveloping leaves was inhibited; in these plants younger growth burst its way through the side of the envelope but the leaf tip still being trapped in the envelope and the envelope still being anchored to the root crown, the stems remained stunted and became grotesquely twisted into distorted loops. The young, still enveloped leaves were distinctly yellow, translucent and wax-like in appearance though on exposure they quickly developed a normal green. The enveloping leaves were dull, papery, and heavily puckered.

A further early symptom was intense brittleness of the plant, but this condition quickly disappeared and it was important only where weeding was attempted soon after spraying.

More persistent affects were:—

- (1) A tendency for the young leaves to be rolled, rather than folded in the bud, giving a spiral twist to the funnel of the plant and giving the plant itself a somewhat one-sided appearance.
- (2) A tendency for some rings of adventitious roots to become enlarged, flattened, more or less fused together, abnormally shortened and heavily coated with a clear, colourless, sticky, watery exudate, to develop a

green colour and sometimes to develop a distinct upward curl. Affected roots in some instances penetrated the soil but the support they provided for the plants was negligible. This effect was confined to one or two rings only of adventitious roots.

Case histories were decidedly confusing, nevertheless the following points were established:—

- (1) While drought at the time of spraying or soon afterwards featured generally, in some instances quite heavy rain fell after spraying and before drought set in.
- (2) Plants sprayed young (below five inches) suffered less than plants sprayed later in growth (above eight inches).
- (3) Directional spraying round the base of the plant caused quite as much damage as general spraying.
- (4) There is no certain evidence that 2.4.D. formulations differ in the severity of the effect they have on maize from corresponding M.C.P.A. formulations.
- (5) Plants in moist, swampy or depressed localities were more affected than plants in nearby drier, elevated localities.

The symptoms developed during a prolonged period of dry weather which set in soon after spraying. With the return of moister conditions, however, the majority of distorted plants quickly recovered and grew away to set and carry a normal crop of maize.

It proved possible on a greenhouse scale to induce most of the maize distortion symptoms which had been recorded in the field. However, success in inducing these symptoms was inadequate for satisfactory examination of the conditions in which growth distortion was likely to develop or of measures remedial to the condition. Nevertheless, the results of the greenhouse scale studies were fully in accord with field observations on case histories.

During 1953, there was some renewal of public concern regarding potential menace of prickly pear. Records exist of T.C.A. and D.N.O.C. being effective in the control of prickly pear and so, using facilities provided by the Parks Superintendent, Nairobi, observational spraying trials using these compounds were undertaken. D.N.O.C. in mineral oil at a concentration exceeding 20 per cent (the formulation used was that used for the aerial spraying of locusts) was dramatic in its effects, quickly reducing all but the older sprayed growth to a pale brown, spongy mess leaving only small patches of living tissue: sprayed plants were not, however, killed outright and the stumps eventually started making fresh growth. Two per cent D.N.O.C. formulation caused only localized and temporary wilting of the plant. The T.C.A. formulation at a 5 per cent concentration in water caused marked yellowing and defoliation of sprayed growth but has been much less damaging at least in its early effects than concentrated D.N.O.C.

Publications

- (1) "Studies in the Fertilizing of Annual Crops in Kenya" (*E.A.A.J.*, 19 (1953), 33).
- (2) "Fertilizer Responses in Relation to Soil Types: Field Recommendations" (*E.A.A.J.*, 19 (1953), 42).

Acknowledgments

Once again it is my pleasant duty to acknowledge the continued co-operation and interest in the work of the Chemical Section shown by its large number of friends. I would also again pay tribute to the cheerful and willing assistance I have received from all concerned in the functioning of the Chemical Section and the development and operation of the Scott Laboratories farm.

The sections of this report on liming studies in Kenya and soil fertility studies in the Kenya Highlands, on moisture determination in maize grain and on analyses of interest undertaken during the year were largely or wholly contributed by Dr. Whelan and Mr. Kempton.

E. BELLIS,
Soil Chemist.

ANNUAL REPORT OF THE SENIOR PLANT BREEDER, 1953

I—Wheat General

THE SEASON

The season, as in 1952, was again dry. Not only was rainfall very short, disastrously so in some areas, but distribution was also poor and patchy. The Njoro/Rongai area suffered particularly badly.

The monthly totals at Njoro, in inches, and the number of days upon which rain fell, were as follows:—

RAINFALL

Month	1953 <i>inches</i>	24 years' Average <i>inches</i>
January	0.35 (3)	0.75
February	0.29 (2)	1.13
March	2.31 (10)	2.62
April	3.52 (16)	5.19
May	1.46 (15)	3.96
June	3.54 (17)	3.54
July	1.69 (10)	4.62
August	3.83 (11)	4.75
September	1.57 (12)	2.30
October	1.82 (12)	1.84
November	3.20 (22)	2.63
December	1.28 (7)	1.85
<i>Total ..</i>	24.86	35.18

The general overall picture is that whereas both April and May rainfall was below average, June produced a normal rainfall figure. July, August and September were all drier than usual. A survey of the table of rainfall figures will show how severely the Njoro area has been hit. Out of the five growing months, May to September, four were below average and three were virtual failures. In addition, showers were in general light and many falls ineffectual. Thus, at Njoro only six falls, and at Rongai only five falls, of over half an inch were recorded during the growing season.

Yields in the lower areas were in consequence poor. In the middle and higher country yields were rather better than expected due to a few late showers in October which came in time to help stands in these areas. This has more than compensated for poor yields in the lower areas and in consequence the Colony's crop, which earlier on looked like being very poor, is likely to be better than average.

ACREAGES AND YIELDS

The Colony's wheat crop this season was 1,329,605 bags of 200 lb. each compared with 1,269,107 bags reaped in 1952. This represents an increase of some 60,500 bags (5 per cent) over the 1952 figure. Corresponding acreage figures are 289,254 for this season compared with 284,031 for 1952 an increase of some 5,000 acres (2 per cent). The average yield per acre was 4.46 bags in 1952, and this has risen to 4.60 bags this season.

The comparison may be summarized as follows:—

1952			1953		
<i>Acres</i> '000	<i>Bags</i> '000	<i>Bags/Acre</i>	<i>Acres</i> '000	<i>Bags</i> '000	<i>Bags/Acre</i>
284	1,269	4.46	289	1,329	4.60

In the Northern Province of Tanganyika 43,384 bags were reaped from 12,033 acres, giving an overall average of 3.61 bags (12.0 bushels) per acre. Yields were seriously reduced due to bird damage by the Sudan Dioch (*Quelea* sp.). This compares with the 1952 figures of 58,310 bags from 12,541 acres, giving an overall average of 4.65 bags (15.5 bushels) per acre. It will be seen, therefore, that the acreage sown decreased by some 500 acres or about 4 per cent. In addition to this non-native production there is a small acreage of African grown wheat. Owing to the drought, coupled with the failure of the maize, most of this crop was consumed locally and very little, if any, came into the local market. In the Southern Highlands Province, the wheat acreage remained at the 1952 level. The acreage sown in 1953 amounted to only 593 acres, yielding the low average of 1.5 bags (5 bushels) per acre due to drought. Some 1,500 acres were sown to the crop in 1951, and about 600 acres in 1952.

Some 65 per cent of the acreage under wheat in Kenya, and about 85 per cent of that in the Northern Province of Tanganyika, was sown to varieties bred at Njoro. The remainder is largely accounted for by introductions released after test.

REVIEW OF MAIN VARIETIES

Varieties grown in the Colony during the season, together with their acreage percentages for the three years 1951–1953, are given below:—

ACREAGES

Variety	1951 %	1952 %	1953 %
Cross 294	31.6	19.2	17.9
Sabanero	15.2	18.1	16.4
1066	9.8	13.4	13.1
131	not specified	9.2	11.2
360.H	5.0	9.3	9.8
Cross 318	16.4	12.1	7.8
Equator	5.3	3.9	7.4
337	not specified	2.1	2.8
D.C. x Ceres	"	0.5	2.1
Pohls Plateau	"	1.5	2.1
341	"	1.1	1.5
184	"	0.5	1.5
261	0.9	1.2	1.0
Regent	1.3	0.4	0.3
Remainder	14.5	7.5	5.1*
	100.0	100.0	100.0
Total acreage:	—	284,031	289,254

* Made up of 17 minor varieties.

The major changes over the three-year period are the drop in popularity of Crosses 294 and 318, to about half the 1951 acreage only, and the rise in the varieties 1066, 131, Equator and 360.H. Sabanero has remained almost unchanged

during this time. The decrease in acreage sown to Cross 294 is considered largely due to its susceptibility to sprouting, which is associated with its open ear habit. It was, in fact, severely damaged in the wet harvest of 1951, and has not recovered from the set-back in popularity it received at that time. It is also becoming increasingly attacked by stem rust, *Puccinia graminis tritici*; and farmers have been warned not to sow too high a proportion of their acreage to this variety. Cross 318 is rather specialized in its requirements and needs good and fertile soil for best results: it has been found to be less successful on poor soils, or land not in the best heart, and has probably declined in acreage for this reason. Nevertheless, it does well in certain areas and still retains its position as one of the Colony's major varieties.

Varieties 1066, 131 and Equator have increased in acreage due to their resistance to yellow ear rust, *P. glumarum*, at high altitudes coupled with their ability to grow on poorer soils. Varieties 1066 and Equator, in particular, are of a drooping habit at harvest, shed rain and are thus not so liable to sprouting in a wet harvest. Equator was very badly damaged by stem rust in 1951, and the acreage sown suffered a sharp drop the following season; but the variety now seems to be staging a come-back. D.C. x Ceres has also shown some increase due to the release of the rust-resistant selection R64 last season.

In order to encourage their production, the high quality varieties Reward, Crosses 184 and 261, and D.C. x Ceres and its selections, were placed in a premium class. This will enable farmers to receive a bonus over and above the price of other varieties for grain of suitable quality. This should have the effect of increasing somewhat the acreage sown to these varieties in 1954.

The newly released variety, R64, a rust-resistant selection from the hard red Canadian spring wheat D.C. x Ceres, proved very popular and yielded well in most areas. Unfortunately it was attacked by stem rust on some farms but the attack was light and no damage occurred. This attack, as discussed later, gives rise to the suspicion that a new physiological form of stem rust has appeared. The durum variety Carleton, released at the same time as R64, has not lived up to its initial promise and was little grown during the season.

RUST AND OTHER DISEASES

Once again stem rust has been widespread within certain varieties, notably 294.M, K. Settler, and 360.H. In most cases the attack has come too late to cause damage; but it offers a warning for the future regarding these wheats, which have become increasingly attacked by rust over the past few years. Hence it is likely that these varieties will decline in acreage in future. Samples of these, and other varieties which rusted in 1953, are being examined: and it seems probable that the latest physiological forms, K9-K12, are responsible.

Leaf rust, *P. triticina*, has been less apparent this season but ear rust, *P. glumarum*, at the higher altitudes, has been more severe particularly in the variety 1066. The new variety, R64, was quite severely affected at Kipipiri and on the Kinangop at 8,300 ft., and should not be grown above the recommended upper limit of 8,000 ft. Areas in which yellow ear rust has caused considerable damage include the high country of Ainabkoi, Kipipiri, and Kinangop. Little glume blotch, *Septoria nodorum*, was in evidence, possibly due to the dry season. One exception was Cross 318 on the Kinangop which was badly affected. This cross seems particularly susceptible to the disease.

A disease which seems to have increased rather alarmingly within recent years, particularly in certain areas, is Take All, *Ophiobolus graminis*. Although Take All can occur on land newly broken from grass its occurrence is usually a sign that the land has been under wheat continuously for too long. The

remedy lies in crop rotation and particularly in keeping susceptible crops such as wheat, and to a lesser extent barley, off affected land for at least two years to starve out the fungus. Alternative crops include maize or oats, and linseed in the higher areas. Where the field has been under crop for a considerable period, a rest under a grass ley may be necessary.

Take All was particularly severe on the Kinangop, where extensive areas of wheat were badly damaged, or even completely destroyed, by the attack. The Kinangop is a comparatively new wheat area in which production on any scale was started only some four to five years ago. Nevertheless cropping to wheat has been intensive and continuous, a factor which favours the establishment and spread of the disease. Signs that Take All was on the increase have been apparent over the past two years, although up to this season no serious damage has taken place. This year, however, the disease has suddenly flared up and assumed serious and damaging proportions; and a radical change in policy from wheat monoculture to a more balanced system of farming is necessary if the crop is to continue to be grown in the area.

Frost also caused quite extensive damage on the Kinangop Plateau, particularly in localized and low-lying areas. Light frosts commonly occur at some time during the growing season in this area, but seldom cause appreciable damage to growing crops. The more severe frost this year is probably attributable to the low rainfall and, with it, lowered night temperatures. Frost damage manifested itself as white blind tips, or completely blind ears, malformed ears, and spikelets with one or more blind florets. The grain which had formed was found to be badly discoloured and shrivelled, and considerable areas of crop were completely destroyed.

An observation of interest is that Cross 318 seems particularly susceptible both to frost and Take All damage: on the other hand R64 and Sabanero show considerably more resistance to frost.

BLACK STEM RUST—POSSIBLE APPEARANCE OF TWO NEW FORMS

There is the possibility that two new physiologic forms of black stem rust may have appeared during the season. This is still the subject of test and, if confirmed, these will make the thirteenth and fourteenth forms of stem rust to be isolated in East Africa.* One new rust form may have attacked 360.H in the breeding cages at Njoro, and the second the newly released premium wheat R64 on the Kinangop. This variety had shown itself in seedling tests to be resistant to the 12 forms of rust so far identified, and it was this attack which gave rise to the suspicion that a new form had appeared. R64 is, in fact, the only variety in Kenya to-day possessing resistance to the 12 known rust forms; and the rust attack, whilst only light and sporadic, does mean that we now have no variety which can be regarded as fully rust resistant.

A field survey carried out in Kenya and Tanganyika during the season showed that the main forms of black stem rust present in both countries were K9 and K12, with K10 and K11 found on a smaller number of occasions. These four are likely to be the chief forms again this coming season and it is unfortunate that, with one exception, all the wheats being grown at the present time are susceptible to one or more of these forms.

The possible appearance of two further rust forms fully emphasizes, if any emphasis be necessary, the ever present danger of rust damage and lends weight to the need for a continuous breeding programme against these diseases. Recommendations as to varieties for the coming season have been published in the local Press.

* Since confirmed.

II—Wheat Breeding

Wheat breeding, coupled with the testing of introductions and first stage multiplication of successful varieties, is carried out at the Plant Breeding Station, Njoro, 7,100 ft. Further testing and multiplication is undertaken at the Eldoret Experimental Farm, 7,000 ft.; the Grasslands Station, Molo, 9,200 ft.; the Rongai plots, 6,000 ft.; Ol Joro Orok Experimental Station, 7,800 ft.; the Kinangop plots, 8,300 ft.; and the Egerton College of Agriculture, Njoro, 7,400 ft.

Climatic and soil conditions vary widely between these various stations which, between them, cover the main cereal producing areas of Kenya.

In the lower areas resistance to black stem rust, *Puccinia graminis tritici*, and to brown leaf rust, *P. triticea*, is necessary; whilst in the higher areas over 7,000 ft. resistance to yellow or stripe rust, *P. glumarum*, becomes essential.

NEW INTRODUCTIONS—1953

Only the more important material is mentioned owing to considerations of space.

Department of Agriculture, Brisbane, Australia.—Lawrence had mixed grain and was slightly attacked by R stem rust. Only the white grains were kept.

University of Stellenbosch, South Africa.—Four *Agropyron* derivatives and nine *Triticum* x *Secale* crosses were tried. The former virtually failed; two of them remained vegetative and the other two gave very poor and shrivelled grain. The *Secale* crosses grew well but were all attacked by stem rust of the R-S to S type. Three only were chosen for initial multiplication—T x S Col 54-1-7, 54-1-10, and 54-1-11. All are being tested for seedling rust reactions.

U.S.D.A., Beltsville, Maryland.—Eleven varieties, some of which replace those lost in the fire, were on trial. The following are being tested in seedling rust tests before deciding on their future usefulness—Surpresa, Timstein, Surpremo 51A, Lerma 52, Red Egyptian, Thatcher-McMurachy-Exchange-Redman (RL.2651), and Titan. The remainder are being multiplied forthwith—Rio Negro, Yaqui-Kentana, and Kentana 52A. Yaqui-Kentana appeared mixed and selections have been made within it. Other material received separately included Quanah, which had a winter habit and became covered with rust: Vigo and Seneca remained permanently in the vegetative condition and failed to ear.

University of California, U.S.A.—C.I.12633, a *T. timopheevi* x *T. vulgare* derivative, remained free from stem rust but had bad leaf yellowing.

Department of Agriculture, Brisbane, Australia.—Of the varieties Spica, Fedweb and Hofed, only the first-named appeared worth immediate multiplication, together with 10 of 12 unnamed selections. All were attacked by stem rust to a varying degree and are being seedling tested to a range of stem rust forms.

The best grain sample was given by SHPFHS 4459.

CAGE MATERIAL

(a) Njoro

No new crosses were made during the season and work was concentrated on sifting through the large number of crosses made in previous seasons. This material consisted of 233 F.1's, of which 106 were straight crosses and 127 back or multiple crosses. Also there were 101 F.2's, of which 70 were run as bulks in the field. In addition there were seven crosses in F.3 or later generations.

Crosses in F.3 or F.4 comprise the following:—

- 372 Newthatch x 184.P.2.A.1.E.
- 374 Newthatch x 192.Q.2.A.L.
- 377 Regent x 291.J.1.I.1.
- 381 Regent x 184.P.2.A.1.F.
- 393 (*T. timococcum* x Marquis) x Regent.
- 398 291.J.1.I.1. x Kenya Governor².

Cross 393 has been discarded in favour of subsequent crosses which have more dilute *timococcum* blood. The remaining five crosses have yielded 74 cultures for 1954 sowing.

(b) Molo

In the Molo cage, selection continued in the two crosses 384 (Equator II x Kenya Ploughman) and 385 (Equator II x 318.AJ.4.A.1), which have now advanced to F.4. There were 81 cultures of the former and 155 of the latter. Selection was again based on shortness of straw, combined with good growth and resistance to yellow ear rust. Many of the cultures appeared pure and it is hoped to promote the best to the initial multiplication series in 1954.

In addition, 27 introductions were grown for test to yellow ear rust at the higher altitude.

The 1066 selections and selected segregates in crosses 361 and 362 were under initial multiplication at Molo, as discussed later.

WHEAT AND OAT RUST NURSERY

A wheat and oat rust nursery was received from the Principal Agronomist, Wheat Investigations, United States Department of Agriculture, Beltsville, Maryland. It contained 1,200 wheats and 100 oats; and it was recommended that the most important material was included in the first 435 wheats. Owing to lack of facilities only these 435 wheats were actually sown.

Scorings for stem rust according to Stakman's system were carried out in September and the results reported back to Beltsville. Seed of the 52 wheats showing the greatest rust resistance, combined with reasonable vigour of growth, was harvested for possible use in our own breeding programme. It is interesting to note that of these 52 wheats a high proportion contain some Kenya blood.

In collaboration with the Food and Agriculture Organization in Rome, co-operative uniform Near East wheat and barley nurseries (1953/54) have been received and will be sown during the coming season.

WHEATS UNDER INITIAL MULTIPLICATION

(a) Njoro

The following introductions of earlier years were grown during the season and a report on their behaviour follows:—

1952 Introductions

Dominion Laboratory of Cereal Breeding, Winnipeg, Canada.—Of the six R.L.2265 x Redman³ selections, only one (R.L.2619) has been kept. It is now the subject of seedling rust tests with a view to its possible use as a parent. Thatcher x (R.L.2265 x Redman²) proved better than the former series but was badly attacked by S stem rust, and will be the subject of seedling tests before a final decision is made as to its future.

R.L.3048 has been discarded as too susceptible to yellow leaf rust. R.L.3093 (Mindum x Carleton) had less leaf rust and will be tried again.

State College, Fargo, North Dakota, U.S.A.—The five *Aegilops squarrosa* x *T. timopheevi* crosses were badly droughted and were attacked by yellow leaf rust and glume blotch. Two only, 3.3.35.1 and 1.11.6.43, have been kept for seedling rust tests and possible use as parents.

Vernum was discarded on account of tall, weak straw; and Rushmore because of susceptibility to yellow ear rust. Two single plant selections in this latter variety will go forward for bulking. No. 4028 proved of very indifferent grain and is not likely to be used further.

Director of Agriculture, Crop Research, Poona, India.—Out of the original 10 Hofed x Niphad and Kenya E144 (our 58F) crosses and selections, five with the best grain characters are to be carried on in 1954.

Central Experiment Station, Algeria.—Hedbar 3 was discarded for severe stem rust attack. The three *vulgare* types were attacked by stem rust of the R to R-S type; Florence x Aurore 8193 by K11; *Aegilops* 1425 by K12; and the third by an unidentified form. The grain was very attractive and these varieties will be carried on further. The durum, Qued Zenati 368, will also be carried on.

U.S.D.A., St. Paul, Minnesota.—Timstein x Newthatch (N.S.II-42-22) was discarded on account of susceptibility to yellow leaf rust and glume blotch. Premier x Bobin² Gaza (N.S.II-39-2) had a fair leaf rust attack and was generally poorly grown. Its future is doubtful and awaits seedling rust tests.

Department of Agriculture, Sydney, Australia.—Festival (C.15418) again was attacked by S type stem rust and has been discarded.

Stazione Fitotecnica, Lombardo, Italy.—Line C from the cross Mentana x *Aegilops ovata*, did not live up to its promise in 1952, was badly attacked by stem rust and has been discarded.

University of Wisconsin, U.S.A.—Of this material C.I.12633 and H462.A.3.7.2.5 were discarded. Those kept now comprise H305-10, C.I.12632, and H462.A.3.4.2.3. In particular the first appears of most promise.

College of Agriculture, Potchefstroom, South Africa.—Maluti and White Spitskop were discarded, the latter for stem rust, form K9, coupled with susceptibility to brown and yellow leaf rust and yellow ear rust. Magaliesberg and Goudveld will be continued at a lower altitude as both were attacked by yellow ear rust at Njoro.

U.S.D.A., Manhattan, Kansas.—These 17 wheats, consisting chiefly of inter-specific and inter-generic hybrids, were tried at the high altitude sub-station at Molo, 9,300 ft., but were all destroyed by yellow rust both on the leaves and in the ears.

University of Sydney, Australia.—The Khapli derivative, K.D.1451, was covered with S stem rust and glume blotch, and was discarded. C.I.12128 and C.I.12500 remained permanently in a vegetative condition as in 1952 and were discarded.

1951 Introductions

College of Agriculture, Potchefstroom, South Africa.—466-4-M-M-1-M was weak in the straw and was badly attacked by glume blotch. It remained free from rust and is to be further multiplied in 1954. Its seedling reactions show resistance to K9 and 11, and susceptibility to K10. 153-M-M was attacked by K9, suffered badly from drought, and is to be discarded. It is resistant to K11, and susceptible to K9 and 10.

A further 10 of these varieties were given further trial, and five will go on to multiplication plots in 1954.

Ministry of Agriculture, Buenos Aires, Argentine.—Benevenuto Inca was generally poor and attacked by leaf and stem rusts. It was discarded. Klein Orgullo, Div.4780, proved better and will be carried on in 1954.

La Prévision 25 had weakish straw and was slightly attacked by stem rust of the R-S type. It showed considerable promise.

U.N.E.S.C.O., East Asia Science Co-operation Office, Shanghai, China.—Pi Yu (Quality) was badly attacked in the field by K10 and by brown leaf rust but gave grain of high bushel weight in spite of the dry season. In seedling tests Pi Yu is susceptible to K9, 10 and 11.

It will be carried on for further trial.

Dominion Laboratory of Cereal Breeding, Winnipeg, Canada.—Iumillo x Mindum (R.L.1642), and Klein 33 (R.L.1885), were badly droughted and attacked by stem rust. They were discarded. Exchange (R.L.1803), lodged badly and was attacked by K12 with pustules of the R type. It is being held in abeyance pending the results of seedling rust tests.

College of Agriculture, Bombay, India.—Both No. 116 and No. 197 again grew well but were attacked to a fair degree by yellow leaf rust. No. 116 also had rust in the ear. Both have been kept for further trial.

Wheat Research Station, Hoshangabad, India.—Of the six wheats which were under trial this season four were kept and will be tried at the lower altitude station at Rongai in 1954. They are Nos. 2, 4, 5 and 7, of which No. 5 appeared the best.

Central Experimental Farm, Ottawa, Canada.—Cascade was badly attacked by stem rust and was discarded. C.A.N.3819 and 3821 remained virtually free from stem rust but grew poorly. C.A.N.3820 was discarded as susceptible in seedling tests to K9, 10 and 11. It had the poorest grain of the group. 3821 is resistant to K11 and susceptible to K9 and 10, whereas 3819 is resistant to K9 and 10, and susceptible to 11.

Agricultural Research Institute, New Delhi, India.—Of six varieties originally received, three (N.P.710, 718 and 760) were grown. Early on they looked nice and proved of quick maturity but towards harvest were strongly attacked by stem rust forms K6, 11 and 11 respectively. In seedling tests N.P.710 is resistant to K11, and susceptible to K9 and 10.

Instituto Agronomico, Brazil.—Of four varieties out of the original eight introductions, two (No. 35 and No. 89) remained free from rust in the field. Frontana and Bandeirantes both had S stem rust, form K12 in the former case.

All four are being held pending the results of seedling rust tests.

1950 Introductions

Dominion Cerealists, Ottawa, Canada.—Hope x Timstein (C.A.N.3751) was in large scale multiplication plots at Rongai and Njoro. It was slightly attacked by stem rust at both centres and by yellow rust on the leaves at Njoro. It came 17th out of 31 entries in the yield trial at Njoro thus bearing out the opinion expressed last season of its moderate yielding ability.

Mida x Cadet (C.A.N.3688) proved very susceptible to drought but is being given a further trial on a farm scale.

Waite Agricultural Research Institute, Adelaide, Australia.—Glenwari, now in its third year, again proved disappointing and has been discarded. Single plant selections were made in Nabawa x (Riverina x Hope) and two of these were bulked at harvest and kept in preference to the original material.

Introductions Prior to 1950

Introductions which had done well in earlier trials now exist in sufficient quantity for field multiplication in 1954. They comprise the following:—

Granadero Klein.—This did very well in the dry season without irrigation. Remained free of disease.

R.L.2150.—Two selections were made in this Marquis² x *Agropyron elongatum* material some years back. Field notes favoured selection B. Both have excellent grain quality with selection A slightly the better.

R.L.2183.—Five selections were made in similar material (Marquis² x *A. elongatum*). There was a fairly high incidence of yellow ear rust in this cross and two selections (C and D) were chosen as being more resistant to this disease. All are of excellent baking quality and show a good balance of characteristics.

Hope x Timstein (C.A.N.3751).—This was grown both at Njoro and Rongai, and suffered badly from drought.

KENYA MATERIAL

Regarding our own material, selected segregates from the crosses 356 (5), 358 (14), 360 (7), and 367 (20) have been multiplied. Three additional 356 segregates, A.2.A., A.4.D., and A.12.C. were put out on a field scale with farmers during the season.

Some notes on the crosses will be of interest.

356 Series (184.P.2.A.1.F. x 192.Q.2.A.L.).—This is a promising cross of good field and baking characteristics. It is likely to be restricted to the low and medium altitudes on account of yellow ear rust susceptibility in the higher areas.

358 Series (184.P.2.A.1.E. x 294.B.2.A.3.).—This is also a useful cross with some segregates, the “P” series, showing excellent baking quality.

360.F.8.X. Series (294.M.7.C.6.C. x 184.P.2.A.1.E.).—A series possessing good short straw and general appearance. The grain, however, is of moderate or poor baking quality.

363 Series (Warigo x 261.S.10.C.2.D.).—These wheats show only fair field characteristics and are not so promising as the other crosses. They also appear to be somewhat mixed for type. Four of these selections were grown at Eldoret.

367 Series (Warigo x 184.P.2.A.1.F.).—These segregates possess good straw but are slightly susceptible to stem and yellow ear rusts. The grain was rather disappointing.

Sabanero Selections.—Four selections out of the original 32 made in 1951 were multiplied during the year. All four are quite different and distinct types.

(b) Rongai

At the low altitude sub-station of Rongai there were five wheats under multiplication, as follows:—

W.1.—This South African variety had done reasonably well in earlier trials, but this season suffered badly from drought and was attacked also by glume blotch. It remained free from stem rust. Its future in Kenya would appear doubtful.

Nabawa x (Riverina x Hope).—This material has been discarded in favour of the selections which have been mentioned earlier in the Njoro section.

Hope x Timstein.—This variety has also been mentioned in the Njoro section. It grew reasonably well but suffered from drought, and was slightly attacked by stem rust of the R-S type

360.F.8.X.6.B.—This member of the series had to be sown at Rongai due to lack of room at Njoro. It suffered badly from drought.

261.X.—A further selection made in this cross which may be useful in the lower country.

(c) Eldoret

Eleven wheats were under multiplication, and all suffered badly from drought. Few field notes could be made.

356.A.4.D.—This is a further selection from this cross additional to those already mentioned.

358.AA.8.B.—The same remarks apply.

359.AA.B.1.A. (291.J.1.I.1. x 184.P.2.A.1.E.).—This particular selection was originally discarded as being of poorer growth than others which have now reached field scale multiplication, but has been revived due to its excellent milling and baking quality.

360.E.13.C.4.I.1. and J.1.—In view of the fact that there are better selections these two will now be left in abeyance.

363 Series.—These have already been mentioned in the Njoro section.

Regent Type (Boy).—A selection from this hard red Canadian spring wheat, made by a local farmer, was under test. It came about average in the yield trial.

(d) Molo

Ten segregates in the cross 361 (Equator x 117.A.), and 19 in the cross 362 (Equator x 294.M.7.C.6.C.), were under multiplication. Some of these latter were in the yield trial at Ol Joro Orok and on the Kinangop. They did particularly well at the latter station.

It has been decided to multiply further selected material in both these crosses; but the actual choice awaits baking tests, the results of which are not available at the time of writing. However, two varieties (362.A.1.D.1. and 362.B.1.E.4.) showed particular promise in the field and will definitely be carried on.

In addition, eight M.K.1066 selections were grown, of which five have been kept for further multiplication. This wheat variety is of very low baking quality, and is not liked by the millers on this account. It is popular with farmers in the higher areas as it is resistant to yellow ear rust. These selections were made to improve straw strength and possibly grain quality but it is doubtful whether either has been achieved.

Other material included selections in Equator, D.C. x Ceres, and Cross 318.

(e) Ol Joro Orok and Kinangop

No wheats were under initial multiplication at Ol Joro Orok or the Kinangop, but variety trials and field scale multiplications were undertaken. (See the next sections.)

VARIETY TRIALS

Yield trials were carried out during the season at the following centres—Njoro, Eldoret, Ol Joro Orok and the Kinangop. Yields are given in bags of 200 lb. per acre in all cases. All trials suffered from drought particularly Njoro and Eldoret.

(a) Njoro

Results at Njoro with 31 varieties were as follows:—

TABLE I. WHEAT VARIETY TRIAL—NJORO

(Randomized incomplete block design—6 replications)

Yield in bags of 200 lb. per acre

Variety	Yield	Bushel Weight lb.	Position
356.A.2.A.	8.40	57	1
360.E.13.C.4.G.	8.37	61	2
*Granadero Klein	8.33	58½	3
*359.AV.1.C.2.C.	8.27	60	4
*358.R.7.E.	8.22	62½	5
*360.H.	8.22	62¼	—
261.E.	8.15	59¼	7
*354.P.3.B.2.B.	8.10	58¾	8
359.AK.3.F.4.B.	8.07	62	9
*360.F.8.D.3.	8.02	59½	10
Regent Type (M-B)	7.93	57½	11
*356.A.4.C.	7.85	58¼	12
359.AK.3.A.5.A.	7.82	61¼	13
358.B.3.G.	7.77	62	14
356.A.12.C.	7.74	58	15
Mida x Cadet	7.72	59	16
*358.AC.4.A.	7.63	59¼	17
*Hope x Timstein	7.63	56	—
356.A.4.D.	7.62	58½	19
359.AA.8.B.3.B.	7.57	62½	20
359.A.2.C.3.D.	7.54	60¼	21
358.B.3.E.	7.40	62½	22
358.B.3.C.	7.39	62	23
358.R.3.C.	7.29	58¼	24
R.L.2183/B.	7.23	56¾	25
358.P.3.D.	6.67	60¾	26
360.E.13.C.6.D.	6.67	59	—
R.L.2150/A.	6.26	57	28
*358.P.7.C.	5.86	61	29
358.P.7.A.	5.77	61	30
W.1.	5.77	58	—
Mean	7.53		
Significant differences—			
P.50 =	0.91		
P.01 =	1.19		

* Varieties also in Eldoret trial (Table II).

The top 21 varieties are all very close in yield and do not differ significantly ($P = .05$). It must be recorded that this trial had to receive some three irrigations of one inch each to keep it alive during the pre-flowering period, and this may well account for the limited range in yields amongst the top-ranking entrants. It is pleasing to note that the 356 series tend to come in the top half of the list (positions 1, 12 and 15), although it is disappointing that the sister cross 358 has on the whole yielded rather poorly. In particular the 358.P. series, previously recorded as having the better grain quality, came quite definitely at the bottom of the list.

(b) *Eldoret*

Results at Eldoret with 25 varieties were as follows:—

TABLE II. WHEAT VARIETY TRIAL—ELDORET
(Randomized incomplete block design—6 replications)
Yield in bags of 200 lb. per acre

Variety	Yield	Position
360.F.8.X.5.B.	7.01	1
360.F.8.X.3.B.	6.48	2
360.F.8.X.6.A.	6.10	3
354.P.3.B.5.B.	5.92	4
*360.F.8.D.3.	5.76	5
358.AC.4.A.	5.40	6
*354.P.3.B.2.B.	5.38	7
354.P.3.B.10.B.	5.34	8
*356.A.4.C.	5.12	9
359.AV.1.B.1.A.	4.95	10
354.P.3.D.4.	4.85	11
Regent Type (Boy)	4.53	12
354.P.3.D.3.A.	4.48	13
363.K.1.B.3.	4.38	14
*Granadero Klein	4.31	15
*Hope x Timstein	4.26	16
*358.P.7.C.	4.23	17
*359.AV.1.C.2.C.	4.21	18
354.P.3.D.3.	3.85	19
*360.H.	3.77	20
360.H.3.	3.75	21
357.P.2.B.1.	3.64	22
363.K.1.B.5.	3.56	23
367.AR.3.B.1.	3.43	24
360.G.1.B.3.	3.35	25
Mean	4.72	
Significant differences—		
P.05=	0.81	
P.01=	1.07	

*Varieties also in Njoro trial (Table I)

In the Eldoret trial the 360.F.8.X. series have done well and all occur at the top of the list. Both 360.F.8.D.3. and 354.P.3.B.2.B. have done well in both trials. Hope x Timstein has done moderately well in both trials; but Granadero Klein, 359.AV.1.C.2.C. and 360.H., all of which did well at Njoro, come in the bottom half of the Eldoret list.

(c) *Ol Joro Orok and the Kinangop*

Results from Ol Joro Orok and the Kinangop with 15 varieties are given below:—

TABLE III. WHEAT VARIETY TRIALS—OL JORO OROK AND KINANGOP

(Randomized block design—6 replications)

Yield in bags of 200 lb. per acre

Variety	OL JORO OROK			KINANGOP	
	Yield	Position		Yield	Position
		1953	1952		1953
D.C. x Ceres R.46	7.32	1	1	2.70	13
D.C. x Ceres R.64	7.21	2	3	3.05	10
Capella ..	6.71	3	—	3.90	6
350.AJ.3.C.1. ..	5.99	4	11	2.80	11
350.AD.9.C.2. ..	5.59	5	6	2.29	15
362.B.1.A.1. ..	5.44	6	4	4.26	4
350.AJ.3.C.2. ..	5.42	7	14	2.80	11
D.C. x Ceres 721	5.26	8	2	3.45	8
362.B.1.A.2. ..	4.69	9	5	3.90	6
350.AD.9.B.1. ..	4.50	10	9	2.60	14
362.A.1.D.1. ..	4.39	11	7	4.40	3
362.B.1.A.4. ..	4.10	12	15	4.76	1
362.B.1.E.4. ..	4.03	13	10	4.50	2
350.AJ.3.A.2. ..	3.75	14	11	3.45	8
362.B.1.A.3. ..	3.28	15	13	4.10	5
Mean	5.18			3.53	
Significant differences—				Low yields due to drought	
P.05=	1.13				
P.01=	1.48				

At Ol Joro Orok, the trial is substantially the same as last season—350.AJ.3.A.1. has been dropped out and Capella substituted. The two D.C. x Ceres selections have again come top as in 1952 and are significantly better than the unselected D.C. x Ceres 721 ($P < 0.01$). Capella, a durum wheat, is of particular interest since it was introduced into Kenya by a farmer and has done well in the high country over the past two years. On the Kinangop the 362 series, developed at Molo, has done well for the season and, as mentioned previously, there is every hope that this cross will prove very useful in the high altitude areas.

WHEATS UNDER FIELD MULTIPLICATION

The variety 351.AS.1.B.2. (117.A. x Regent 975.6.) which was attacked by K12 in 1952 during its early multiplication, was given a further trial during the present season. Its future was then considered doubtful, but it was decided to proceed with its multiplication since the pustules were of the R to R-S type

which denoted some degree of resistance. During 1953, the variety was under trial at Endeless, 6,000 ft., and on the Uasin Gishu Plateau at 7,000 ft. Rust attack was again in evidence on some farms although no damage was apparent. Further multiplication will be carried out during the coming season with a view to release at the end of 1954.

The varieties which were under multiplication at Rongai, 6,000 ft., suffered severely from drought and very little seed was obtained. Two of these, 359.AK.3.A.5.A. and AV.3.F.4.B., were lost altogether, and they will not now be revived. The remainder at Rongai, 360.E.13.C.6.D., 360.F.8.D.3., 359.AA.8.B.3.B. and 359.AV.1.C.2.C., returned small yields and will be grown again during the coming season. The four durum varieties, R.L.1742 and R.L.3047 from Canada, and Russo and Argelino from Portugal, have been discarded as they were found to be too low in general strength to be acceptable for milling.

At the Egerton College of Agriculture, Njoro, 7,400 ft., Mida x Cadet was found to be very susceptible to drought but will be given a further trial elsewhere. 356.A.12.C., growing alongside, stood up to drought well and is to be continued. At Endeless, both 356.A.2.A. and 354.P.3.B.2.B. showed promise, but 359.A.2.C.3.D. was quite severely attacked by brown leaf rust. A Regent selection from a local farmer was found to have weak straw and lodged: it may, however, be of use in the less fertile soils of other areas. Of the three 261 selections, one, 261.E., was multiplied at Solai, 6,000 ft., where it yielded well in spite of the dry conditions.

At Ol Joro Orok, fresh stocks of two established wheat varieties, 318.AJ. and 360.H., were multiplied in anticipation of the start of a pedigree seed scheme. As this scheme is in abeyance this seed will not be taken further.

RELEASE OF NEW WHEATS

No new wheats were released during the year under review.

III—Barley

For the first time hybridization has been undertaken this season and is mentioned in the section on Cane Material.

New Introductions—1953

Agricultural College, Fargo, North Dakota, U.S.A.—Moore, a six-row type, proved very lush early on but at harvest had weak straw and scattered S stem rust, *Puccinia graminis*. The grain was quite nice.

Agricultural Experiment Station, Logan, Utah, U.S.A.—Two derivatives from Winter Club x (Coast x Lion), (B.120-106 and B.120-88-14), and a selection from the cross Velvon x Wisconsin (C.I.7558) were under test. All grew very poorly, were weak in the straw, produced poor grain and were discarded.

U.S.D.A., Beltsville, Maryland.—Colonial (C.I.7570), MoB-400 (C.I.7568) and Cascade (C.I.7146) were received. The first two proved to be winter types and remained in a vegetative condition. Cascade had excellent straws and will be tried again.

Agricultural College, Stillwater, Oklahoma, U.S.A.—Harbine (C.I.7524), Tenkow (C.I.646) and Ward (C.I.6007) were received too late in 1952 for a fair trial and were sown again this season. Harbine proved a winter type and, after a long vegetative period, eventually eared giving very poor grain and was discarded. Tenkow was mixed for spring and winter types, was badly attacked by S stem rust and was discarded. Ward formed grass-like clumps and took seven months before beginning to shoot. It will be tried in the higher, colder country.

Plant Breeding Institute, Cambridge, England.—Proctor (Plumage Archer x Kenia), stood up to the dry conditions comparatively well and will be multiplied in 1954.

CAGE MATERIAL

A crossing programme was started during the season using a range of Scandinavian type barleys and the Australian varieties Research and Prior. These latter are the established barleys in Kenya and are very extensively grown. The object of the programme is to combine the short straws and heavy yielding powers of the Scandinavian types with the drought resistance and wide adaptability of the Australians.

The Scandinavian varieties used were Kenia, Ymer, Carlsberg, Heimdal, Herta, Maja and the similar types No. 5 from Eire and Proctor from Cambridge.

BARLEYS UNDER INITIAL MULTIPLICATION

1952 Introductions

Department of Industrial Research, Christchurch, New Zealand.—The three Research selections were again grown and ran true to their characters of early, and mid-season, and late. The mid-season selection had the best grain, whereas the late selection had the best field notes but the poorest grain. The crosses Kenia x Chevalier and Maja x H.H.12 were carried a stage further in bulk selection.

U.S.D.A., Logan, Utah.—Bonneville (C.I.7248) was vigorous, with smooth awns and large heads. It proved too late for Njoro and will be tried at Molo in 1954.

Central Experiment Station, Algeria.—Of the four barleys kept from 1952, Orge Bordier 2838 was again the best, but was too late maturing. This variety, and Orge 839, will be tried at Molo.

Dominion Laboratory of Cereal Breeding, Winnipeg, Canada.—Ottawa 3092.A. proved of vigorous spring habit. It suffered badly from yellow leaf rust, *P. glumarum*, and became kinked under the neck at harvest as in 1952. It was discarded because of these poor field notes and poor grain.

Department of Agriculture, Nicosia, Cyprus.—Of the original introductions only one, B.M.C., was grown. Initially it showed a very vigorous, early, spring habit and was of extremely short straw. It was badly attacked by yellow leaf rust and at harvest was smothered by weeds. It was too poor to keep.

1951 Introductions

Department of Agriculture, Dublin, Eire.—Thirteen Spratt Archer derivatives were grown, of which five were included in the yield trial. All these were uniformly disappointing and proved to have weak straws and drought susceptibility. Two were rather better, Spratt x Archer 23 and 74. No. 5 (Kenia x Spratt Archer x Kenia), a different and more typically Scandinavian type, looked more promising and yielded well in the trial.

In addition, a range of Scandinavian varieties was sent, most of which were included in the yield trial at Njoro. Those not included in the trial were Bonus, Binder, Rigel, and Rika. The latter was discarded as being a sister to Herta and having no apparent advantage over this variety.

Institute for Research on Field Crops, Wageningen, Holland.—All were badly droughted but Mansholt's 2-row proved better than Goudgerst, as in 1952. Balder and Agio were included in the yield trial.

Ministry of Agriculture, Buenos Aires, Argentine.—Of the original 13 introductions, six were grown during the season—La Estanzuela 702, Buck 42, Engeldow India, La Prévision 19, Klein Bb.7.500 and 5.100, of which the first two have been kept for trial in the higher country. The remainder were discarded for poor growth and grain.

Agricultural Experiment Station, Zürich-Oerlikon, Switzerland.—Adliker 9 grew well, as in 1952, and gave reasonable grain. It will be carried on for further trial.

Earlier introductions are dealt with in the notes on trials and field multiplication.

VARIETY TRIALS AND OBSERVATION PLOTS

Yield trials were sown at Njoro, Kitale, Ol Joro Orok and the Kinangop.

(a) Njoro

A yield trial of 16 barleys was put down at Njoro.

TABLE IV. BARLEY YIELD TRIAL—NJORO
(Randomized incomplete block design—6 replications)
Yield in bags of 180 lb. per acre

Variety	Yield	Position	Bushel Weight lb.
Heimdal	13.46	1	50
Kenia	11.65	2	51
No. 5	11.54	3	50 $\frac{3}{4}$
Ymer	11.27	4	47 $\frac{1}{2}$
Balder	10.80	5	50 $\frac{3}{4}$
Carlsberg	10.24	6	48 $\frac{1}{2}$
Maja	10.11	7	48 $\frac{3}{4}$
Research	9.35	8	50 $\frac{1}{2}$
Agio	9.18	9	49 $\frac{1}{2}$
Herta	7.24	10	50 $\frac{1}{4}$
Argentine C	7.13	11	50 $\frac{1}{4}$
Spratt x Archer 77 ..	7.10	12	48 $\frac{1}{4}$
Spratt Archer x Spratt 2/99	7.00	13	49 $\frac{1}{2}$
Spratt x Archer 20 ..	6.93	14	49 $\frac{1}{2}$
Prior	6.88	15	51
Humes Archer	6.34	16	49 $\frac{1}{4}$
Mean	9.14	—	—
Significant differences—			
P.05=	1.55		
P.01=	2.07		

The trial was given three irrigations of one inch each, as with the wheat, during drought conditions in the pre-flowering period. The winner, Heimdal, was obviously the heaviest yielder as seen visually in the field, and was characterized by extremely vigorous growth and tillering and a great capacity to suppress weeds. Conversely, Prior, Argentine C and Research were of very thin growth and lacked weed suppressing power. Agio and Herta, in the Scandinavian types, were also very weedy and could be picked out by eye as being the poorest in this group.

It is evident that the Scandinavian types, and No. 5, are of high yielding ability in Kenya as elsewhere and are well suited to this country. This bears out the experience with Kenia and Ymer over a number of years' experimental work. The Spratt Archer group is disappointing at this altitude but trials will continue at the higher altitudes which may be more suitable. It may be mentioned that the "classical" English barleys, Spratt Archer and Plumage Archer, are grown only to a very limited extent in Kenya as they are generally of lower yielding ability than the commonly grown Australian types.

(b) *Kitale*

The barley trial of eight varieties, the same as in 1952, was badly droughted and smothered by weeds. No results were obtained but, visually, Wisconsin, Sanalta and Prior seemed the best. It has been emphasized before that barley trials in the Trans Nzoia should be sprayed against weeds, since from our experience of barley in this area weeds are a limiting factor. It is necessary either to have a very aggressive barley, which can grow away quickly and smother weeds, or efficient control of weeds by a suitable chemical spray.

In addition to the yield trial, 19 varieties from North America, together with a selection of other barleys, were again under observation. They were badly droughted and suffered severely from weed competition. This was not a very satisfactory test but the better varieties were Velvet, Vantage, Plush, Tregal, Trebi and Velvon. The poorest were Regal, Prospect, Peatland, Titan and Newall. It is hoped to try out a range of Scandinavian types which are more aggressive and may be better able to compete with weeds.

(c) *Ol Joro Orok*

The result of the trial with 11 varieties is as follows:—

TABLE V. BARLEY YIELD TRIAL—OL JORO OROK
(Randomized block design—6 replications)
Yield in bags of 180 lb. per acre

Variety	Yield	Position	
		1953	1952
Velvon	16.67	1	—
Prior (Hopkin's)	15.26	2	—
Trebi	14.92	3	1
Ymer	14.07	4	2
Prior (Standard)	14.02	5	4
Kenia	13.72	6	6
Herta	13.64	7	—
Tregal	13.51	8	—
Research	11.92	9	5
Ray	11.75	10	3
Golden Archer	8.25	11	8
Mean	13.43		
Significant differences—			
P.05=	2.13		
P.01=	2.81		

The barley occupying the head of the list, Velvon, has done very well at Njoro and Eldoret in the past and has proved top over a period of three years at Njoro. This was discussed in the 1952 report. It is interesting to note that this variety also retains its high yielding ability in the higher area of Ol Joro Orok. It shows wide adaptability coupled with high yield and should be a valuable addition to the country's feed barleys. Arrangements are being made to multiply it in 1954.

Of the Scandinavian types, Ymer has again slightly out-yielded Kenia, which is the case in other countries. Golden Archer repeats the experience with this type, and is too low yielding to be of interest to farmers.

In the observation plots, Swanneck and Cape appeared the best in a group which included Chilian 2-row, Atlas, Vaughn and Sea of Azov. The latter three grew tall and had weak straws.

(d) *Kinangop*

The yield trial failed due to drought.

(e) *Molo*

Small observation plots of seven barleys were sown to determine the suitability of these varieties for growing in the high country, where resistance to yellow ear rust, *P. glumarum*, is essential. Research, Kenia and Ymer stood best; Prior, Maltworthy, Earl and Standwell grew too tall and lodged. All remained free from ear rust.

BARLEYS UNDER FIELD MULTIPLICATION

The following varieties were under field scale multiplication:—

(a) *Njoro*

Sea of Azov at Egerton College. This proved very susceptible to drought, soft strawed, and was a virtual failure.

(b) *Rongai*

Both Blue barley and Czech barley were almost lost due to drought, and less than the original seed recovered. They will be sown again in 1954.

(c) *Eldoret*

Atlas failed completely due to drought and no seed was harvested.

(d) *Kitale*

Four barleys, Velvet, Trebi, Velvon and Ray, were multiplied. The first two proved the best and all four will be continued.

(e) *Ol Joro Orok*

Ymer was grown by various farmers but was severely affected by drought and little seed was obtained.

Standwell was obtained from Cambridge but there is no certainty as to its trueness to type. It grew very lush and lodged.

Earl, an early selection out of Spratt Archer, unfortunately became mixed and the grain had to be discarded. A fresh start will have to be made.

Trebi was grown at Ol Joro Orok as well as at Kitale. It grew poorly this season.

In addition, Herta, Research and Prior were grown as foundation stock for the pedigree seed scheme earlier mentioned in this report. As in the case of the wheats, this seed will not be taken further.

(f) *Kinangop*

Vantage and Ray were under multiplication and grew reasonably well. Ray is an unidentified variety imported by a local farmer and carried under his name.

(g) *Molo*

Two British winter barleys, Prefect and 6-row Dense, were grown during the season. Prefect grew well and had rather better straw this year, due possibly to the dry conditions.

Six-row Dense proved late, taking some six and a half months to maturity and stood well. It may be of use in areas where long-term feed varieties are required.

RELEASE OF NEW BARLEYS

The two Scandinavian varieties Kenia and Herta were released to farmers at the end of the season.

Notes on their characteristics and allied information were published in the local Press for the advice of farmers.

IV—Oats

The work with oats has followed the lines explained in previous reports, and is based upon the testing of introduced material.

There has been continual disappointment year by year with oats at Njoro, due chiefly to stem rust, *Puccinia graminis*, and crown rust, *P. coronata*. For this reason it has been decided that the bulk of the oat work will move to the higher country at Molo and Ol Joro Orok this coming season.

New Introductions—1953

Dominion Laboratory of Cereal Breeding, Winnipeg, Canada.—Two Hajira x Richland derivatives (R.L.127 and 148) proved free of disease but had weak straws. A Hajira selection (R.L.559.16) was clean but of poor growth and thin grain. Hajira x Banner (R.L.524) was slow, remained vegetative over a long period, and was covered with stem rust. Canuck x Victory (H-566) remained semi-vegetative and was also rather less attacked by stem rust.

University of Idaho, U.S.A.—Nine varieties were received, as follows—Cody (C.I.3916), Overland (C.I.4181), Neosho (C.I.4141), Kent (C.I.3909), Zepher (C.I.4800), Marida (C.I.2571), Shelby (C.I.4372), Andrew (C.I.4170), and Clinton (C.I.3971). The last two had been received in a previous season and this seed was therefore put to stock. Cody and Neosho remained free from stem rust, and the others were attacked but only slightly. Kent was noticeably weaker in the straw, and Shelby remained vegetative too long and was caught by the dry season. Overland was of strong straw and should prove useful.

In addition five crosses were received—Clinton x Marion (C.I.5641), 4189 x Overland (C.I.5347), Clinton x Overland² (C.I.5345 and 5346), and Victoria-Richland x Bannock (C.I.3865). The Overland crosses, as Overland itself, appear to be rather well suited and show promise. The last-named cross was noticeably weak in the straw.

U.S.D.A., Tennessee.—La Conte and Forkeddeer proved disappointing and became covered with stem rust at an early stage.

Central Experimental Farm, Ottawa, Canada.—The variety Fortune has been under trial in the past, and did very well at Molo.

U.S.D.A., Bettsville, Maryland.—Six (Antony-Bond) x Boone selections (C.I.5430–5435) did reasonably well, remained free from disease but were rather slow. C.I.5430 was shorter and had fairly strong stem rust attack. C.I.5433 and 5434 were discarded as of poorer growth.

In addition, Mindo x Landhafer (C.I.5439) remained clean and gave plump grain. Clinton x Santa Fe (C.I.(?) 5431), a broader-leaved type, stood well but appeared mixed for chaff colour. C.I.5207 and 5208 appeared mixed, were weak strawed and lodged. They had fair general stem rust.

University of Illinois, U.S.A.—Seven derivatives from various Clinton, Marion, Columbia and Benton crosses were received. Clinton x Columbia 43-283 was attractive and almost free from rust. The reciprocal selection (Columbia x Clinton 43-271) was taller and weaker strawed. From the cross Marion x Clinton came three selections and an F6 hybrid population. Selections 46-543 and 47-21 proved the better, being shorter and more sturdy; 47-32 was decidedly weak strawed. All remained clean. The hybrid population contained a number of shorter, stronger plants and should yield useful material. A similar Benton x Marion F6 hybrid population was notable for its excellent panicles.

University Farm, St. Paul, Minnesota, U.S.A.—The variety Foxtail (Victoria x Hajira-Banner) was very lush, broad leaved and late. In spite of its tallness it stood well. It remained free from rust.

University of Florida, U.S.A.—The variety Southland was received with notes that it is resistant to Victoria blight, *Helminthosporium victoriae*, and moderately resistant to crown rust. It grew well, looked exceptionally even and attractive. There was a slight infection of stem rust. The straw was somewhat weak, but the panicles were good, and of the denser type. Floriland (C.I.6588), also received at the same time, was not so successful; it seemed to ear directly from a winter habit. It remained free from rust.

CAGE MATERIAL

As in previous years no programme of hybridization was undertaken, though some crossing in the open was attempted to see what success could be obtained. A range of times was chosen, but all attempts failed. Poor technique may have been responsible but the exceptionally dry conditions prevailing at the time were a further cause for the failure. In future it will be necessary to keep plants for crossing under moister conditions.

The cage work was otherwise confined to the examination of the introductions mentioned above.

OATS UNDER INITIAL MULTIPLICATION

(a) *Njoro*

A large number of oat plots were grown, but they suffered badly from the drought in spite of periodical irrigation. Once again both stem and crown rusts were very active and in some cases fully lethal. This is in contrast to the cages, in which the rust was relatively mild. Comments on the various varieties are given below:—

1952 Introductions

Dominion Laboratory of Cereal Breeding, Winnipeg, Canada.—The two derivatives from the cross R.L.1574 x Roxton (R.L.2105 and 2123) were destroyed by drought and rust. R.L.2100 (R.L.1574 x Ajax) was more successful, less rusted, and some seed was harvested.

The group of accessions noted as received late for the 1952 season were grown again with the 1953 introductions and have been referred to in full in that section.

Central Experiment Station, Algeria.—All five varieties were badly attacked by stem rust. Both Rouge 31 and 61 failed to set seed. Noire 912 was the most vigorous, being exceptionally leafy in early growth. It was less damaged by rust than Palestine 1947 or Coura 977.

Central Experimental Farm, Ottawa, Canada.—Lanark grew very vigorously at first, became badly attacked by stem rust on both stems and panicles, and set little seed.

Agricultural Experiment Station, Denton, Texas, U.S.A.—The four varieties Fulwin, Mustang, New Nortex and Stanton were held back by drought and then damaged by stem rust. The last three were noticeably less rusted than Fulwin and most other varieties in the same series of plots. Fulwin broke badly before harvest. (Fultex, the other member of this group, was grown at Molo.)

Agricultural Station of Alaotra, Madagascar.—Avoine Burh and Banner Regen were rather poor and did not appear heavy yielders. In spite of fair stem rust attack they produced good grain for this season, especially the latter. Avoine 095 was of better growth, less rust, but mixed grain.

1951 Introductions

Agricultural Experiment Station, Zürich-Oerlikon, Switzerland.—Rosegg 2 grew fairly well, but was again attacked by stem rust.

Agricultural Experiment Station, Minnesota, U.S.A.—Of the large group of derivatives from the Hajira-Joanette crosses mentioned last year, Hajira-Joanette itself stands out for better growth and absence of rust. All the others did very well at first, but were badly attacked by stem rust and destroyed before harvest. Small quantities of remnant seed will be available for testing in the higher country at Molo.

Dominion Experiment Farm, Ottawa, Canada.—Beaver, as in 1952, was severely attacked by stem rust and destroyed. Beaver 1948, mentioned later, was similarly destroyed.

Iowa State College, U.S.A.—Clinton, Bonda, Benton and Eaton were very vigorous and lush at first, but were all destroyed by stem rust before harvest. Mindo, in a larger plot, was less attacked by rust and a crop was harvested.

1950 Introductions

Central Experimental Farm, Ottawa, Canada.—Of this group of introductions, R.L.811 was better than the rest, and less attacked by rust and is clearly worth further multiplication. Garry (1948), Ajax (1948), Beaver (1948), and Beacon (1948) looked well at first but were destroyed by stem rust before harvest. 3003.F (1948) was less attacked by rust, did well, and is also referred to under trials and field scale multiplications, at Eldoret and Ol Joro Orok respectively.

State Research Farm, Werribee, Victoria, Australia.—Algeribee, Palestine, Dawn and Orient were all destroyed by rust before harvest. Sunrise was very slow and late, and came to nothing.

(b) Eldoret

Four oats were under multiplication during the season, as follows:—

R.L.1674 and 1734 (Victory x (Victoria x Hajira-Banner)) were received in 1946 from the then Dominion Laboratory of Plant Pathology, Winnipeg, Canada. Both grew well this season and showed themselves as hay or silage types. The latter came 13th in the trial out of 21 entries and was also successful at Kitale. Boone and Vikota are milling types received in 1940 and 1948 respectively from the United States Department of Agriculture, Washington. Both did well and will be carried on.

(c) Kitale

R.L.1734, as noted above, was multiplied, did well and will be grown on a farm scale in the coming season. Of Vichland, Cedar and Vikota the former proved the best but all three will be further multiplied. Vichland came from the U.S. Department of Agriculture in 1942, and Cedar similarly in 1945. Vikota has been mentioned already in regard to work at Eldoret.

(d) Molo

No multiplication plots were sown, but a range of oats under observation is discussed in the section on trials and observation plots.

(e) Ol Joro Orok

As at Eldoret and Kitale, the oat R.L.1734 was multiplied. It grew vigorously and looked a successful hay or silage type. 3003.F (1948) was tall and slightly attacked by stem rust and appeared to shed easily. It was also grown at Njoro, as already mentioned, and came 16th in the Eldoret trial out of 21 entries.

Seven single plant selections from the milling oat, Grey Algerian, were grown. Three of these were selected, on best bushel weight and yield, for multiplication in 1954.

OAT VARIETY TRIALS AND OBSERVATION PLOTS

Yield trials were sown at Eldoret and on the Kinangop.

(a) Eldoret

The Eldoret trial with 21 varieties gave the following results:—

TABLE VI. OAT VARIETY TRIAL—ELDORET
(Randomized incomplete block design—6 replications)
Yield in bags of 150 lb. per acre

Variety	Yield	Position
Lampton	18.45	1
Ajax	17.48	2
Achilles	15.97	3
*Bcone	15.52	4
*Mindó	15.43	5
Control	15.06	6
Cedar	14.88	7
*Tama	14.64	8
*Vikota	14.40	9
R.L.1694	14.13	10
R.L.1681	14.04	11
*Vichland	13.98	12
*R.L.1734	13.82	13
R.L.1692	13.40	14
*R.L.1674	13.31	15
3003.F. (1948) ..	12.43	16
Fultex	12.04	17
Clinton	10.89	18
R.L.1710	9.14	19
Grey Algerian AB.2	6.05	20
Grey Algerian ..	5.54	21
Mean	13.36	
Significant differences—		
P.05 =	0.86	
P.01 =	1.15	

* Best varieties in observation plots at Eldoret in 1952.

Lampton, the established feed variety, shows its great yielding capacity and adaptability. Ajax and Achilles (2nd and 3rd respectively) are also feed types.

Of those varieties in the trial, the following are under multiplication—Boone, Cedar, Vikota, R.L.1734 and 3003.F (1948).

Grey Algerian and its selections do best in the high country, and their position at the bottom shows that they are not suited to the Eldoret area.

In observation plots, Landhafer x (Mindo x Hajira-Joanette) grew the best, with R.L.811 (Canuck) coming second; Beaver and Bonda were poorer.

(b) *Ol Joro Orok*

A trial of 13 varieties was grown at Ol Joro Orok and the Kinangop. Results are appended:—

TABLE VII. OAT VARIETY TRIALS—OL JORO OROK AND KINANGOP

(Randomized block design—6 replications)

Yield in bags of 150 lb. per acre

Variety	Ol Joro Orok			Kinangop	
	Yield	Position		Yield	Position
		1953	1952		1953
Boone	9.75	1	5	5.86	5
Tama	9.27	2	—	5.88	4
Vichland	9.25	3	6	8.68	1
Lampton	8.89	4	4	2.58	12
Ajax	8.74	5	1	3.36	11
Achilles	8.30	6	2	3.74	10
R.L.1734	8.01	7	—	5.55	8
Control	7.57	8	3	6.25	3
Vikota	7.18	9	7	5.44	9
R.L.1674	7.03	10	9	5.78	7
Cedar	6.64	11	10	5.83	6
R.L.1681	5.44	12	7	8.46	2
Grey Algerian ..	2.26	13	—	—	—
Mean	7.56			5.62	
Significant differences—					
P.05=	1.96			1.52	
P.01=	2.36			2.00	

Broadly speaking, the order of merit follows the same pattern as in 1952, and it will be seen that all the first six varieties show promise. It may be noted that Vichland, R.L.1734 and 1674 were multiplied at Eldoret, and R.L.1734, Vikota and Cedar at Kitale. It would seem that Boone, Vikota, Vichland, Control, Cedar and Tama are all grain types, whereas the remainder are likely to be more suitable for silage or hay. All varieties were slightly attacked by rust but no damage was caused.

In observation plots, R.L.811, Landhafer x (Mindo x Hajira-Joanette) and Beaver were all good; Bonda, Clinton and Mindo grew less vigorously, shed easily and gave little seed. This compares with Eldoret, where R.L.811 and the Landhafer type were also the best.

(c) *Kinangop*

The 21 varieties in trial on the Kinangop were the same as those at Ol Joro Orok and the results have been given above in a joint table (Table VII). Yields on the Kinangop were low due to late planting and drought. It is seen that

varieties that did well at Ol Joro Orok have not necessarily repeated their performance on the Kinangop, and vice versa; R.L.1681 is a case in point. However, Boone, Tama and Vichland have maintained their positions at both centres.

Again, in the observation plots Landhafer x (Mindó x Hajira-Joanette) was outstandingly the best, remaining comparatively free from rust. The remainder, R.L.811, Clinton, Mindó, Beaver and Bonda were heavily attacked by rust and yielded poorly; Clinton was virtually destroyed.

OATS UNDER FIELD MULTIPLICATION

No oats in the current programme have so far reached the stage of multiplication on a farm scale, but R.L.1734 and 3003.F (1948) will reach this stage during the 1954 season.

V—Maize

The work consists of two distinct sections: (1) the hybrid programme and allied work; and (2) the breeding for resistance to *Puccinia polysora*, which is undertaken in collaboration with the East African Agriculture and Forestry Research Organization (E.A.A.F.R.O.).

Puccinia polysora is confined to the coastal areas of East Africa, and has not so far spread to the higher country inland. It is therefore convenient to consider this problem separately from the main maize breeding work.

A—HYBRID MAIZE

The Njoro work suffered seriously from the exceptionally dry season and a great deal of valuable material was lost. It was unfortunate that irrigation equipment was sufficient to irrigate only the small grain crops, and the maize had to rely on natural rainfall. Hand watering of the most valuable material, notably the fixed inbred lines, was carried out daily, but proved to be relatively ineffectual. As a result of this, the general programme of inbreeding was set back at least one year and the synthetic variety and all trials were completely lost. In addition, the bulking of the 13 fixed inbreds failed, as did also their crossing in all possible single cross combinations. The trials lost comprised material of the following types—44 double crosses, 2 new synthetics and 19 top crosses.

At Kitale, the programme fared better and achieved its objects but, owing to staff shortage, only a limited programme could once again be undertaken. The work consisted of further inbreeding, coupled with a large top-crossing programme. These top crosses will be in trial in 1954, to enable the Kitale material to be evaluated for yielding ability. In view of the failures at Njoro, a crossing programme was cancelled, and selfing was substituted in the hope of bulking up the equivalent fixed inbred lines to those at Njoro.

New Introductions—1953

All introductions are tested at Njoro and then, if useful, become incorporated in the inbreeding programmes. New introductions totalling 52 were grown during the season. Owing to the dry season leaf blight, *Helminthosporium turcicum*, was not prevalent as in normal years. The main disease was rust, *Puccinia sorghi*.

Rockefeller Foundation, Columbia, South America.—Ten varieties were received, representing collections of material from that region. These were Eto (F51 B), Col.2 (M51 A), Rocol V.I. (S51 B), Rocol V.101. (P51 B), Cuba.2 ‡‡ (6057 ‡‡), Ven.1 ‡‡ (6505 ‡‡), Cos.303 ‡‡ (4802 ‡‡), Cos.302 ‡‡ (4815 ‡‡), Cal.301 ‡‡ (4808 ‡‡), and Ven.39 ‡‡ (4813 ‡‡). Cuba.2 was discarded, and the remainder were selfed, to give 17 cob rows for 1954.

University of Wisconsin, U.S.A.—Material received at two different times comprised the following Wisconsin hybrids—W240, 255, 275A, 335, 341A, 416AA, 464A, 525A, 641AA, and 1600. They were sent with a note that they varied from 80 to 115 days' maturity, in that order. All were very short (about 3–3½ ft.), and were badly attacked by rust, *P. sorghi*. They are obviously unsuited to Njoro, but selfing of some hybrids was undertaken to obtain lines with the rapid maturity.

W275A and W341A were the strongest and most vigorous hybrids, and W240 the poorest.

Department of Agriculture, Sydney, Australia.—Six inbreds were sent which were reported to be resistant to leaf blight, *Helminthosporium turcicum*. All six were badly attacked by rust and almost failed. Selfing was carried out on three lines to continue the material.

U.S.D.A., Beltsville, Maryland.—Five Southern hybrids and open pollinated varieties, together with eight inbred lines, were received. These inbreds were reported as having given good results in the short season areas of Australia.

Four of the five were destroyed by rust, and only Mexican June set one inbred cob. The inbred lines grew poorly, six failed completely due to rust, and two (K4 and CI 21) set one selfed cob each.

Department of Agriculture, Nyasaland.—Of the eight open pollinated varieties received from various sources, Krug and British Honduras were not selfed as they proved too poor. The remainder, Kronstad Robyn, Silver King, Early Pearl, Bushman, Chester County and 90 Day, set between them ten selfed cobs.

Owing to the bad season, suitable material from the original introductions will, where possible, be given a fresh trial in 1954.

WORK AT NJORO

In a total of some 360 cob rows grown during the season, 83 of these were derived from Njoro maize, 134 from other Kenya maizes, and 85 from various introductions. The remainder consisted of the direct importations referred to above.

The programme of inbreeding was greatly hampered by the drought and many lines failed to set seed. As a result of this, there can be little advantage in analysing the data on the material harvested. Instead, the sowing programme for 1954 is given which combines 1953 seed with remnant seed from 1952 brought forward to compensate for losses.

The new programme involves the sowing of the following groups of material:—

- (1) 51 Njoro Lines.—25 S6's, 9 S5's, 10 S4's and 7 S3's.
- (2) 64 Other Kenya Lines.—8 S4's, 38 S3's, 17 S2's and 1 S1.
- (3) 107 Lines from Introductions.—9 S6's, 11 S4's, 6 S3's, 28 S2's and 53 S1's.

These comprise lines derived from the following countries: 8 from Southern Rhodesia, 10 from Nyasaland, 10 from South Africa, 13 from Australia, 35 from the U.S.A., 9 from Mexico, 17 from Columbia, 1 from Indonesia and 4 from the Himalayas.

Notes on the 1953 introductions cover much of the material derived from importations. However, the following additional notes are given where there are points of interest.

Southern Rhodesia.—There are now inbred lines at both S6 and S4, derived from S.R. hybrids. They are short, grow poorly, and also rust badly; but one of the S6 lines derived from 9 H 20 was much more satisfactory and may prove useful. All are considerably earlier than the local maize.

South Africa.—There are lines from white and yellow maizes, flints and dents. All seem to respond poorly under drought conditions and set little seed in 1953. They are earlier than Njoro maize.

Australia.—In addition to the inbreds mentioned in the 1953 introductions, a range of varieties had previously been received. Victory, Standfast, and DS30 have given lines now at S2; all were more drought resistant than most other lines in 1953, and gave small cobs, with yellow-orange grain. The remainder of this series have now been discarded.

Mexico.—A collection of Mexican maizes was first grown in 1952 and certain of these were notable for their freedom from rust. In particular there are now lines derived from Chis 25, Vandeno, Chis 94, Comiteco and Amarillo de Cuba, all of which show signs of rust resistance, Chis 94 being the most promising, as in 1952. Chis 95 (Olotillo), and 2605-1 were discarded.

Indonesia.—The variety Menado was grown in 1952 and again in 1953. Both the variety and an S1 line derived from it droughted badly but the line was the better.

Himalayas.—One S1 line derived from Himalayan maize was grown in 1953, and did surprisingly well. It proved very drought resistant and stood well. Four S2 lines will now be sown in 1954.

In the crossing programme, 45 combinations of 10 fixed inbreds were attempted but almost all failed, and the work must be repeated. These single crosses would have been in trial in 1954 to give data for the production of the best possible double cross combinations.

On the results of the 1952 top-cross trial, two synthetics were made up from remnant seed (1st and 2nd choices). The former was planted in isolation for multiplication, and for top crossing on to a range of 80 inbreds. This failed, as did multiplication of the 2nd synthetic. Nine lines used in the synthetics were revived from old seed for continuation by modified composite sibbing. Few cobs were set and the project was a failure. This work would have prevented fragmentation of the lines with consequent gene loss, and would have preserved them for further use.

WORK AT KITALE

The programme at Kitale has been discussed in outline in the initial paragraphs of this section. The following notes give some further details.

The inbreeding programme involved the sowing of 244 lines. Selfing was carried out in 152 of them, but only 134 of these merited harvesting. Some 220 cobs have been chosen in the laboratory for further sowing.

The top-crossing plot comprised 12 fixed inbreds and a further 86 lines of Kitale origin from the inbreeding programme. Of these crosses 79 will be in trial in 1954.

A small trial of 10 double crosses was sown but was inconclusive, since a mistake in sowing rendered analysis impossible.

B.—PUCCINIA POLYSORA

With the appearance of *P. polysora* in East Africa in mid-1952, a programme of testing both local and introduced maizes was inaugurated by the E.A.A.F.R.O. at Muguga. This work took the form of intensive juvenile testing in the glasshouses. At the same time field tests were carried out by the various territorial agricultural departments, which ran parallel and in conjunction with the programme at Muguga.

Accordingly, an experimental programme was started in 1953 on the Department's station at Kibarani, on the Kenya Coast, with the object of transferring resistance to *P. polysora* from introduced lines to adapted local varieties. A collection of 42 varieties of both local and exotic maizes was supplied by E.A.A.F.R.O. for this work.

Selfing and sibbing of these maizes yielded 92 and 134 cobs respectively, and 231 crossed cobs were obtained. Nineteen lines showed signs of useful field resistance, and 118 cobs in 60 combinations were obtained from them.

The practical difficulty encountered was to distinguish susceptible and resistant plants before flowering, for *P. polysora* did not build up in the field in 1953 until after the plants had flowered. If this occurs in future seasons, it will complicate the work; and consideration may have to be given to creating an artificial rust epidemic.

The work will continue using this material and, in addition, it is hoped that further more purified material will be available from Muguga in 1954.

VI—Other Crops

DWARF CASTORS

Due to a revival of interest in this crop a number of dwarf types was grown at Njoro in isolated multiplication plots. In addition, observation plots were sown at Rongai, Kitale, Nairobi and Embu. These varieties are now in sufficient quantity for trial, and comprise the following: Nos. 72, 73, 74, 93 and Conner from the U.S.A., Mauthner from Hungary, Mamona U38 from Brazil, and a dwarf type (unnamed) from Bechuanaland. In particular, Conner, Mauthner and the Bechuanaland type were suitable for combine harvesting. Samples from all plots have been sent for oil analysis but no data have been received at the time of writing.

SUNFLOWERS

A trial of two giant and six dwarf varieties was carried out at Eldoret. The object was to show that dwarfs, if planted sufficiently closely, can yield as well as or better than giants, and have the advantage of mechanised harvesting.

From the 1952 trial, it appeared that dwarfs are better seed yielders than giants, though differences are narrowed down if compared on an oil yield basis.

The fully dwarf variety, Sunrise, was further bulked at Kitale during the season.

SORGHUMS

Owing to Emergency duties, the work at Machakos was held in abeyance in 1953, but observation plots were grown at Kibos in Nyanza Province and at Matuga on the coast. The former station is situated on black clay loam a few miles from Lake Victoria, Nyanza, at an altitude of 4,000 ft.

(a) Kibos

At Kibos, observation plots of 111 varieties of sorghum from various sources were sown as the first step in obtaining improved varieties for grain and fodder. The origin of the varieties was as follows: 24 from Nyasaland, 12 from Tanganyika, 20 from North Nyanza, 46 from Central Nyanza, 3 from Kitui and 6 from Southern Rhodesia. The rainfall during the six months of the trial, April to September, was 19 inches compared with the average of 26 inches, and was less well distributed. Notes were taken on tillering, height, density of head, grain colour, days to maturity, and potential usefulness for grain or fodder. Each plot consisted of a single row of 1/259th-acre. Rows were two feet apart.

Data on heights, days to maturity and yield per plot are summarized in the table below:—

TABLE VIII. HEIGHTS, MATURITIES AND YIELDS OF SOME SORGHUMS

ORIGIN	HEIGHT, FEET		MATURITY, DAYS		YIELDS PER PLOT LB.	
	Range	Average	Range	Average	Range	Average
	ft. in.—ft. in.	ft. in.				
Nyasaland ..	2 3–6 11	4 11	106–134	113	Nil–10·9	6·7
Tanganyika ..	2 4–8 0	5 2	106–139	129	4·2–20·0	10·2
North Nyanza ..	4 2–6 8	5 7	119–139	126	6·1–13·5	10·0
Central Nyanza ..	4 5–7 8	6 1	119–156	124	Nil–28·0	8·6
Southern Rhodesia	2 4–3 6	3 2	96–144	95	3·0–5·1	3·7

(b) Matuga

The variety “Bird-proof” from South Africa, which had shown promise in earlier observation plots, was planted out for bulking and about 15 lb. of seed obtained. Feterita Managil from the Sudan was also planted for bulking.

Shortage of staff due to the Emergency seriously hampered the work at the coast.

VII—Publications

(1) “The 1953 Seed Maize Competition” in the *K.I.O. Fortnightly* No. 3590 of 15/2/54, and in the local Press.

(2) “Cereals in Kenya for 1954–55” in the *K.I.O. Fortnightly* No. 268 of 15/3/54, and in the local Press.

(3) A paper entitled “Puccinia Polysora in Maize—Progress Report on Breeding Work, I” was delivered to the Specialist Committee on Agricultural Botany at Muguga in November, 1953.

VIII—Acknowledgments

My thanks are due to Dr. R. M. Nattrass, Senior Research Officer (Plant Pathology) for testing and identifying physiologic forms of stem rust, and the production of inoculum for the artificial rust epidemic in the breeding cages. I thank also the Agricultural Officers at Eldoret, Kitale, Ol Joro Orok and the Kinangop, the Pasture Research Officer at Molo, and the staff of Egerton College of Agriculture for conducting the considerable amount of work at the various out-stations. Messrs. Unga Ltd. have given much help, both in examining and testing grain for baking quality and by the work of their field officer, Mr. K. Howes, regarding wheat crop statistics. For all this help I am most grateful.

Not least my thanks are due to the staff of this station for making the work of the season run so well in a year of particular difficulty.

H. C. THORPE,
Senior Research Officer (Plant Breeding).

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STEM RUST

At Njoro (7,100 ft.) difficulty is expected in maintaining the rust forms in a pure condition, since, during the wheat season, the spore concentration in the air is heavy and natural contaminations have occurred in the nursery stock. To overcome this to a certain extent, wheats susceptible to only one form are to be used for rust culture. Thus, 357.AB.1.D.7 is to be used for K9 because it is resistant to the other forms. Similarly, Granadero Klein is to be used for stock cultures of K10, 360.H for K11 and 359.AV.1.B.1.A for K12. In this way by using only the largest pustules for bulking purposes, it is hoped that the forms may be kept free of contamination.

During the hot dry season, the difficulty previously experienced in Nairobi of keeping the rust cultures alive, occurred at Njoro. In the greenhouses, temperatures of 112°F. and more have been reached.

Since no water has, as yet, been laid on to the greenhouses, no form of humidity and temperature control has been possible. Under these conditions, bulking of rust has been found erratic, sometimes a fairly good take with hypodermic inoculations occurring and at others, practically nothing. Leaf inoculations in general, fail, even when humidity is maintained by enclosing the inoculated plants under alkathene bags or bell jars. These difficulties might, to some extent, be overcome by fitting humidifying and cooling devices such as fans blowing through boxes containing continually moistened charcoal. In this respect, the brick chambers are superior to the glasshouses in that temperatures remain fairly low. However, since they are open to the wind, it was not considered safe to attempt to use them for maintaining the stock cultures, and their use has been limited to rust identity tests.

One new form, K13, has almost certainly appeared, and probably another, K14.* K14 was obtained from D.C. x Ceres R64, which until then had been immune to all the Kenya rust forms. K13 was found on 360.H from the Plant Breeding Station. 360.H was, until then, only attacked by K11. As the differentials at present in use are all susceptible or resistant-susceptible to both these forms, a search will have to be made for suitable additional varieties to incorporate in the series. It is a pity that the full American Tester Series cannot be grown to maturity here, since a change to that series, if the difficulty of seed supply could be overcome, would put us into line with the rest of the world. It would at first cause various complications, but in the end would achieve closer synthesis with wheat breeders working on the American system, now in general use.

CEREAL DISEASES

Wheat.—*Puccinia graminis* continues to be the major wheat pathogen but severe attacks of *P. glumarum* and *P. triticea* have occurred. *Ophiobolus graminis* is as prevalent as usual and will continue to be so long as wheat monoculture is so prevalent a farming practice. Advice on the control of this disease by better farming methods has been given on numerous occasions. Unfortunately it is not always taken. *Fusarium* spp. have been found from several sources, causing foot-rots. *Helminthosporium sativum* has as usual caused some damage and a new fungus in Kenya, *Pyrenophora tritici-repentis*, has been responsible for great loss in some crops. *Septoria tritici* and *S. nodorum* have both been encountered but attacks were not heavy. "Black Point" was caused by *Alternaria*

* Since confirmed.

sp. and *P. tritici-repentis*. "Second growth" has been fairly prevalent, particularly on the Kinangop. This was due to a long spell of drought in the middle of the growing season leading to partial dormancy of the plants, followed by renewed growth and tillering with late rains.

Barley.—No specimens were received from farmers, but *Helminthosporium teres* and *Rhincosporium secalis* were prevalent on material at the Plant Breeding Station. *Puccinia graminis* was also present and *Ustilago nuda* occurred in some crops.

Oats.—Some varieties in the Plant Breeding Station plots were very heavily attacked and partly destroyed by both *P. graminis* and *P. coronata*.

Maize.—As usual, *Helminthosporium turcicum* and *Puccinia sorghi* were common. *P. polysora* is not known to have occurred outside the areas already recorded. Rotten cobs were examined and *Fusarium graminearum* and *Nigrospora oryzae* were isolated. One plant on the Plant Breeding Station was found with "leopard spotting" and, as before, no pathogen could be found. This and the Trans Nzoia disease (apparently a bacterium—*Fusarium* complex) need further investigation.

Teosinte.—A heavy attack of *Puccinia sorghi* occurred on *Euchlaena mexicana* in the breeding cages.

Experimental Work

Puccinia Graminis

Attention has been called to a problem regarding the use of only seedling resistance tests as the basis of wheat breeding work. In general, plants resistant as seedlings are found to be resistant as adults. This has not held throughout, as some wheat varieties have been found attacked in the field by a rust form to which they were seedling resistant. This is an unusual phenomenon, for while it is widely known that plants susceptible as seedlings may develop a mature plant resistance, the reverse is known to have occurred in only a very few instances. It now appears that, in some Kenya crosses at least, mature plant tests in addition to seedling resistance tests will have to be undertaken, if the full rust resistance is to be evaluated. Experiments have been started to determine the genetic factors involved, but results cannot be expected for several years.

Pyrenophora tritici-repentis (Diedicke ex Dreschler) Dreschler

This fungus was recorded for the first time in Kenya this year. As certain crops were badly damaged and as little appears to be known about the disease, investigations were undertaken.

The disease appeared on D.C. x Ceres R64 at Londiani, Kipipiri and Njoro. This variety appears to be particularly susceptible. Severe reductions in yield were recorded, amounting in one case to some three quarters of the average yield of the rest of the crop.

The disease was shown to be seed borne; and it was found that a good measure of control could be obtained by using organo-mercurial seed dressings. A survey was then carried out, and the fungus proved to have a wide distribution, apparently having been present in Kenya for some time, and possibly having been passed earlier as *Helminthosporium sativum*.

A notice to farmers advising the general use of seed dressings was prepared for the local Press.

Ophoholus Graminis

Following a conversation with a farmer of many years of observational experience, who stated that a certain wheat was returning to popularity due to its resistance to Take All, experiments were at once started to determine whether or not this wheat does in fact possess resistance. While resistance is not unknown, it appears to be a very uncommon character.

It is still too early to state definitely that this Kenya wheat is resistant, but preliminary investigations tend to confirm the farmer's opinion.

Publications

(1) A note was sent to *Nature* on "Seedling Resistance—Mature Plant Susceptibility to Black Stem Rust in Wheat". It has not yet appeared.

(2) A paper on *Pyrenophora tritici-repentis* was prepared. It is to be printed in the April edition of the *East African Agricultural Journal*.

A. D. S. DUFF,
Plant Pathologist (Plant Breeding).

ANNUAL REPORT OF KITALE GRASSLAND RESEARCH STATION, 1953

Rainfall

The mean annual rainfall at Kitale is 46 inches. The following table gives the monthly distribution of rainfall and the number of rainy days which occurred in 1953. Similar data for the two preceding years are given also, for comparison—

	1951		1952		1953	
	Rainfall	No. of Rainy Days	Rainfall	No. of Rainy Days	Rainfall	No. of Rainy Days
January ..	0.82	5	Nil	Nil	0.14	1
February ..	0.36	8	0.20	4	0.16	1
March ..	3.42	13	4.69	10	0.50	4
April ..	8.48	21	7.53	22	5.84	18
May ..	5.12	18	7.25	22	7.23	12
June ..	3.90	15	2.85	12	6.86	21
July ..	5.86	22	2.92	18	3.26	16
August ..	4.98	18	6.91	21	5.89	15
September ..	2.28	14	2.45	13	1.20	7
October ..	4.78	16	4.52	16	3.32	16
November ..	5.23	20	1.33	12	1.85	14
December ..	4.43	15	0.05	2	1.02	8
TOTAL ..	49.66	185	40.70	152	37.27	133

The season's rainfall was below average and its distribution unsatisfactory, particularly in May and September, when two relatively dry spells occurred.

Grass and Legume Nurseries

The grass and legume nurseries, together with small-scale multiplication plots, amount to over 15 acres. The object of nursery and plant introduction work is to obtain a sufficiently large range of species from which suitable ones may be selected for the wide range of conditions which occurs in Kenya. The number of grasses and legumes on trial in the nursery at present totals over 900 different species, strains and samples. Suitable species are multiplied as soon as they seem sufficiently promising. When enough seed or planting material becomes available, they are tried out on a larger scale and used also in field experiments, in which they are subjected to critical tests. In 1953, about 420 new plantings were made from roots and seeds obtained in Kenya or from other countries, particularly Australia and the U.S.A.

Large collections of the more important pasture and fodder grasses were planted for study in 1954. These included, among many others, varieties of Rhodes grass, Molasses grass, Guinea grass, Star grass, Signal grass (*Brachiaria brizantha*), *Setaria sphacelata*, *Setaria splendida*, and *Cenchrus ciliaris*. Preliminary evaluations in 1953 and during previous years had shown a number of superior varieties, including leafy, vigorous and more stoloniferous forms of Rhodes grass, better and more vigorous forms of Molasses grass, *Setaria*, Guinea grass and Signal grass, and forms of *Cenchrus ciliaris* which are better suited to grazing.

A number of grasses were studied particularly from the point of view of re-seeding denuded and over-grazed land in dry areas. A species of *Eragrostis*, obtainable locally and from South Africa, *Cenchrus setigerus*, and also seedling varieties of Star grass (*Cynodon plectostachyum*) may turn out to be suitable for the purpose.

Among exotic grasses examined in 1953, two species of *Paspalum* (*P. malacophyllum* and *P. regnelii*), and two of *Pennisetum* (*P. pedicellatum* and *P. sub-augustum*) showed up fairly well. All species and varieties of grasses from temperate regions of Europe and America gave poor results. The climate at Kitale, at 6,200 ft., does not seem suitable for these species.

A number of strains of *Glycine javanica* were examined from the point of view of fodder production and a small-leaved type was examined for its grazing potential. The numerous varieties collected from various places differ considerably in their length of growing season and in leaf and seed production. A number of other species of large and productive, fast-growing twining legumes continued under examination from the point of view of their use as fodder plants. On the whole, it is less likely that large-leaved legumes will be suitable for pasture purposes.

Of the legumes introduced in 1953, *Teramnus uncinatus* for fodder, *Desmodium canum*, *D. uncinatum* and *Centrosema plumieri* seem to merit further study and trial.

A comprehensive report on the many details of the nursery work and on the performance of the various species and strains, has been prepared for publication in the *East African Agricultural Journal*.

Preliminary Grazing Trial of Species (1952 First Rotation Trials)

Duplicate plots of a very large number of grasses and legumes were established in 1952. In 1953, one plot of each species received lenient treatment, that is, it was neither mown nor grazed until it had made tall growth. The other series of plots were grazed hard whenever growth was sufficient. All plots received 1 cwt. per acre of double superphosphate in 1952 and again in 1953. By the end of 1953 the hard and lenient treatments showed the following differences, as measured on Rhodes and Molasses grass:—

GROUND COVER

					Average Score
<i>Rhodes Grass</i> —					%
Lenient treatment	..	..	..	..	72
Hard treatment	..	..	..	..	64
<i>Molasses Grass</i> —					
Lenient treatment	..	..	..	..	62
Hard treatment	..	..	..	..	44

There was a noticeably greater number of flowering heads produced under the hard grazing treatment:—

AVERAGE COUNT OF FLOWERING HEADS PER SQUARE YARD

					Number of Flowering Heads
<i>Rhodes Grass</i> —					
Lenient treatment	..	..	..	..	1.5
Hard treatment	..	..	..	..	5.2
<i>Molasses Grass</i> —					
Lenient treatment	..	..	..	..	2.5
Hard treatment	..	..	..	..	7.4

Generally speaking, plots showed greater vigour and were more attractive under lenient than under hard treatment. In particular, this was the case with some of the twining legumes, with lucerne, and with some of the more erect tufted grasses which lack ideal form for grazing.

From over 40 grasses and over 40 legumes tested, the following species have emerged from the trial as promising for grazing, for general purpose leys or for fodder:—

- (1) GRASSES.—*Brachiaria brizantha*, *Setaria splendida*, *Hyparrhenia* sp. nr. *hirta*, *Beckeropsis unisetata*, *Panicum maximum*, *Melinis minutiflora*, *Cenchrus ciliaris* and *Chloris gayana*.
- (2) LEGUMES.—Lucerne, *Alysicarpus glumaceus*, *Stylosanthes gracilis*, *Trifolium rueppellianum*, *Trifolium cheranganiense*, *Trifolium semipilosum* and *Medicago denticulata*.

1952 Second Rotation Trial Leys

Three cuts were made on four one-acre ley plots established in 1952, but no grazing took place until the latter part of the year. Plot yields expressed in tons per acre of air-dry material, were as follows:—

GRASS	YIELD (tons per acre air-dry material)				
		1st Cut	2nd Cut	3rd Cut	Total
<i>Beckeropsis unisetata</i>	O	0·90	0·12	0·15	1·17
	N	0·90	0·11	0·14	1·15
<i>Setaria sphacelata</i>	O	0·80	0·15	0·20	1·15
	N	1·70	0·13	0·18	2·01
<i>Panicum maximum</i>	O	1·30	0·19	0·22	1·71
	N	1·40	0·17	0·20	1·77
Molasses	O	1·70	0·25	..	1·25
	N	2·20	0·25	..	2·45

N.=Sulphate of ammonia was applied at $1\frac{1}{2}$ cwt. per acre after each cut.

Of the four mixtures, *Panicum maximum* and *Brachiaria brizantha* were outstanding, the latter species being an ideal bottom grass for the *Panicum*. *Setaria sphacelata* also did well but was too dominant for *Chloris gayana*. Molasses grass was disappointing after the first cut: it tended to die back and allow poorer species to come in. Of the legumes, *Alysicarpus glumaceus* did well in the *Panicum maximum* ley.

The Utilization and Management of Elephant Grass

During the year an experiment was begun on Elephant grass to study fully its utilization and management. Two cuts were obtained before the end of the year and the following records were obtained: (i) there was no significant difference in yield between 3-ft. and 7-ft. row spacings; (ii) inter-row cultivation caused a 50 per cent increase in yield over uncultivated rows; (iii) sulphate of ammonia, applied as a top dressing at the beginning of the season, and after

cutting the grass, gave a 50 per cent increase in yield over the controls; (iv) the combination of sulphate of ammonia and cultivation gave increases in yield of over 200 per cent over controls; (v) the presence of legumes between the rows did not increase yields.

Elephant Grass as a Dry Season Grazing Ley

In another experiment on Elephant grass, established this year to study its potentialities for dry season feeding, no significant difference in yield was found between 3-ft. row spacings and 7-ft. spacings. Sulphate of ammonia increased yields by 60 per cent, but little difference in yield occurred whether the grass was cut to ground level or the stubbles were left uncut.

The Effect of Fertilizers, Cultivations and Surface Seeding, on the Quality and Productivity of Natural Grassland

Observations continued for the third season in order to assess the relative merits of different treatments on the quality and productivity of natural grassland. Records over the past two years have shown that surface seeding of grass species and legumes does not yet appear to be an economical farming proposition and observations this year lend support to this view. Surface seeding of natural grassland has not been successfully accomplished with the particular species involved and the techniques employed. Slightly better establishment was achieved where harrowing at the time of sowing was done and where a combination of fertilizers, namely, 2 cwt. per acre of sulphate of ammonia and 200 lb. per acre of double superphosphate had been used. The fertilizers assisted to promote better establishment of legume and of grass species. *Alysicarpus glumaceus*, *Dolichos falcatus* and *Glycine javanica* are the most promising legumes, while Molasses grass and, to a lesser extent, *Brachiaria brizantha* are the most promising grasses.

The Fertilizing of Established Molasses Grass for Seed Production

An experiment begun in 1951 to study the effects of a phosphatic and a nitrogenous fertilizer on the production of Molasses grass seed was brought to completion this year. The fertilizers were single superphosphate, applied at 0, 36 and 72 lb. P_2O_5 per acre, and sulphate of ammonia applied at 0, 15, 30, 60, 90 and 120 lb. N per acre. The experiment was designed in the form of a quasi-Latin square, composed of 18 treatments and 2 replications, giving a total of 36 plots each 1/40th of an acre in size.

The total yield for the three-year period, expressed in lb. seed per acre, is given below:—

	N ₀	N ₁₅	N ₃₀	N ₆₀	N ₉₀	N ₁₂₀	Mean
P ₀ ..	133·10	215·30	288·15	360·32	364·38	316·89	279·69
P ₃₆ ..	132·16	184·67	313·14	367·16	415·95	332·19	290·88
P ₇₂ ..	133·12	235·62	291·84	367·52	324·67	411·88	294·11
Mean ..	132·79	211·86	297·71	364·97	368·33	353·65	

Throughout the three-year period, the effect of nitrogen on growth has been marked, but phosphate has had no visible effect on growth or seeding of the grass. The heavier dressings of nitrogen, N₄ and N₈, caused a collapse in growth and seeding of the grass in 1952, and its replacement by couch, sedges and other undesirable species in 1953. During this period, pH values had fallen to 4.9,

compared with the control value of 5.9. The most satisfactory dressing of nitrogen probably is 30 cwt. per acre of sulphate of ammonia, and at this rate of application, it may be used economically with 2 cwt. per acre of single superphosphate.

No apparent variation due to fertilizer treatments was obtained from germination tests carried out on samples of seed obtained from individual plots on two separate occasions.

Lucerne Variety Trials

In 1952, 17 varieties of lucerne were sown, and most of the plots established were cut four times this year. Final growth, corresponding to a fifth cut, was left for seed production. Each plot of each variety received 1 cwt. per acre of double superphosphate and 3 cwt. per acre of muriate of potash at the beginning of the year. Throughout the season, records were kept of resistance to leaf diseases and of vigour, form and quality. The following types show promise: Hairy Peruvian from South America, Booborowie from Australia, Rhizoma from the Argentine, selection No. 4 F.A.V.B.A. from the Argentine and Pampeana, also from the Argentine.

A further 17 varieties of lucerne were sown this year. These included several varieties from America and Australia as well as two selections made locally at Kabete by D. C. Edwards. The seed was inoculated prior to sowing and 1 cwt. of double superphosphate and 1 cwt. of muriate of potash were given to the seedbed.

Observation Treatment on Weeds and Weed Seeds with Agrozone "3"

During the year, a preliminary observation trial using Agrozone "3" was carried out to study the effect of five concentrations of this substance on *Tagetes minuta* and *Bidens pilosa*, or, as they are commonly called, Mexican marigold and black jack. Concentrations of Agrozone "3" were as follows:—

(1)	0.46%	..	..	..	1 : 213
(2)	0.92%	..	..	..	1 : 108
(3)	1.70%	..	..	..	1 : 64
(4)	2.50%	..	..	..	1 : 43
(5)	3.40%	..	..	..	1 : 32

Plots sprayed on 3rd September with concentrations (2), (3), (4) and (5) had wilted by the following day. Complete kill varied on the same plots between the third and the fifth week after spraying. Plants on plot (1) were dead at the end of six weeks. By the end of September, *Chloris pycnothrix* and *Cynodon dactylon* had covered up to three-quarters of the ground in all plots.

Seed samples of *Bidens pilosa* were tested for germination, seed being collected from the ground and from upright plants. The following are average germination figures from three plots of 100 seeds, and from each plot, after one month:—

Concentration of Spray per cent					Average Germination per cent
0.46	..	..	..	..	22
0.92	..	..	..	..	Nil
1.70	..	..	..	..	Nil
2.50	..	..	..	..	Nil
3.40	..	..	..	..	Nil
Control	..	..	..	..	98

Good control of weed seed germination has therefore been achieved.

Co-operative Experiments

In addition to work done on the Station, many co-operative experiments with local farmers were carried out, to study—

- (1) the effects of sulphate of ammonia and superphosphate on ley establishment;
- (2) methods of sowing leys; for example, sowing the grass alone and sowing it with oats for grazing or for harvesting;
- (3) the most suitable grasses and legumes for particular localities;
- (4) the suitability of different grasses for seasonal swamp conditions;
- (5) fodder grasses for dry season production;
- (6) Nzoia Rhodes grass seed production in a 22-acre block at Eldoret;
- (7) chemical methods of bush control in the Cherangani Hills.

Information obtained from these experiments is being incorporated in a series of articles written by a member of the Pasture Research Team, and these will appear in due course in the *Journal* of the Royal Agricultural Society of Kenya.

MOLO GRASSLAND RESEARCH STATION (W. R. BIRCH)

Meteorological

The year was generally warm and dry. Although the total yearly rainfall was only 13 inches below normal for the district, most of it fell in small amounts, and was relatively ineffective, due to the abnormally hot sunny weather. A meteorological screen has now been installed and complete data will be obtained in 1954.

				Rainfall	No. of Rainy Days
				<i>Inches</i>	
January	..	..	..	0.36	2
February	..	..	..	—	—
March	..	..	..	0.95	5
April	..	..	..	3.89	11
May	..	..	..	4.35	11
June	..	..	..	5.31	14
July	..	..	..	3.16	13
August	..	..	..	5.56	17
September	..	..	..	2.64	10
October	..	..	..	2.51	15
November	..	..	..	0.98	9
December	..	..	..	2.20	7
TOTAL				31.91	114

Soil Temperatures

Daily readings were started in March, 1953, and the table below summarizes the results for the year ending February, 1954. These readings were taken under a natural grass cover of red oat grass which is never cut or grazed.

MEAN MONTHLY SOIL TEMPERATURES °F

MONTH	8 A.M.			2 P.M.		
	2 in.	4 in.	8 in.	2 in.	4 in.	8 in.
1953—						
March	52.5	55.5	56.4	61.4	56.1	56.2
April	54.3	56.7	57.3	61.6	57.3	57.2
May	53.2	56.0	56.6	59.5	56.8	56.9
June	53.8	55.9	56.4	58.1	56.4	56.4
July	51.7	54.4	55.4	56.9	55.0	55.5
August	53.3	55.3	56.0	57.8	55.6	55.9
September ..	52.3	55.4	56.2	58.5	55.7	56.4
October ..	53.1	55.5	56.4	58.7	56.2	56.4
November ..	53.0	55.5	56.5	58.1	56.1	56.6
December ..	52.7	55.2	56.1	57.9	55.6	56.0
1954—						
January ..	51.2	54.5	55.4	58.1	54.9	55.4
February ..	52.1	55.6	56.6	61.3	56.2	56.4
Yearly Mean ..	52.8	55.4	56.3	59.0	56.0	56.3

The main interest in these figures is the very small variation in soil temperatures throughout the year, at the three depths studied.

Experimental Work

The main emphasis in 1953 was on ley establishment, particularly on old arable land which supports such a dense weed population that cereal growing is not profitable. The experiments included both grazing trials and small plot cutting trials and the main items are summarized below. Lack of equipment and of funds for experimental work tended somewhat to reduce the efficiency of the year's programme.

The Effects of Rolling the Seedbed and of Sowing at Varying Depths

In this experiment, an attempt was made to compare different degrees of rolling and depths of sowing Cocksfoot and Perennial Rye grass, the former having been sown with S.100 white clover and the latter with S.184 white clover. Rolling treatments included: (i) rolling before and after sowing; (ii) rolling before sowing; (iii) rolling after sowing; and (iv) no rolling. These treatments were imposed on sowing-depth treatments, which were—

- (1) bottom notch on depth lever with springs loose;
- (2) second notch on depth lever with springs loose;
- (3) bottom notch on depth lever with springs under tension in Hole No. 4;
- (4) second notch on depth lever with springs under tension in Hole No. 4;
- (5) bottom notch on depth lever with springs under tension in Hole No. 5;
- (6) second notch on depth lever with springs under tension in Hole No. 5.

The drill used is an I.H.C. grain drill and the bottom notch was an extra one filed in the bar so that the drill sowed as shallow as the clutch allowed. These treatments were used with S.37 Cocksfoot sown at 5 lb. per acre in 7-in. rows, and Commercial Perennial Rye grass at $6\frac{1}{2}$ lb. per acre. Double superphosphate at 150 lb. per acre, was drilled with the seed.

Although the management of this trial was adequate (grazing and mowing), the clovers did not establish at all and it is likely that the season was too dry for these English legumes. The grasses established well, and Rye grass plots which had received the two rollings were outstanding. Cocksfoot did not respond to rolling to the same extent. No significant differences were observed between depth treatments, but if any differences exist, they may appear in 1954 when grass yields will be obtained from clippings.

Effect of Lime on Grass Establishment in Weedy Land

In an unreplicated experiment, lime obtained from Kenya Marble Quarries was applied at 0, $\frac{1}{2}$, 1, 2, 4 and 6 tons per acre to plots one-fifth of an acre in size, before the grasses were drilled. Plots were split and S.24 Perennial Rye grass was drilled in 7-in. rows at a rate of $7\frac{1}{2}$ lb. per acre in each half plot and Olsgaard Cocksfoot, at 8 lb. per acre, was drilled in each of the other half plots. Double superphosphate, at 180 lb. per acre, was drilled with the seed. Five rows each of S.100, S.184 clovers, and Trefoil were drilled across each plot.

No major effect from lime was observed either on grass or on weed growth. On account of the relative dryness in 1953, it was unlikely that results would be noted during this establishment year and the trial will continue in 1954. Sheep and cattle showed no preference for any one liming treatment, and the legumes failed except on the plot which received six tons per acre of lime, where a poor establishment of Trefoil survives.

Effect of Seeding Rates on Grass Establishment in Weedy Land

In order to compare grass establishment on very weedy land when different seeding rates are used, a randomized block experiment, with two replicates, was laid out and plots 90 × 96 ft. were split into three sub-plots of 90 × 32 ft. for seed rate comparisons. The main treatments were as follows: (1) Olsgaard Cocksfoot; (2) S.37 Cocksfoot; (3) Commercial Perennial Rye grass; and (4) S.24 Perennial Rye grass. Sub-plot treatments were: (i) a low seed rate of 8-10 lb. per acre; (ii) a medium seed rate of 13-16 lb. per acre; and (iii) a high seed rate of 16-21 lb. per acre. The grasses were drilled in 7-in. rows by an I.H.C. grain drill, with 150 lb. per acre of double superphosphate.

The plan of this experiment was modified during the season when, for some reason, two plots of Block II did not establish as quickly as others. The statistical design was therefore ignored, and the following extra treatments superimposed across the sub-plots: (i) spraying with Agroxone "3", at 4 pints per acre, in a strip across each plot; (ii) top dressing with sulphate of ammonia at 2 cwt. per acre over one-half of each plot; and (iii) heavy management on Block I versus light management on Block II.

The experiment was sown under ideal conditions and despite 24 days of dry weather after sowing, all grasses germinated quickly and survived well. The nitrogenous top dressing produced very slight beneficial effects on cover and growth, presumably because of inadequate rainfall after fertilizer application.

Spraying with Agroxone "3" at 4 pints per acre gave excellent weed control when sprayed 7 weeks or 9 weeks after sowing. In the former case the Cocksfoot had 5-6 leaves, and the Rye grass 5 leaves, and were starting to tiller. Spurrey was 1 in. high and Campion (*Silene gallica*) was in the cotyledonary stage. In the latter case the grasses were all tillering; the Spurrey was 2-3 ins. high and the Campion in the 4-6 leaf stage. No adverse or toxic effects on the grasses were noted, but the Spurrey, though not killed, ceased to grow. Campion was reduced to a negligible amount and Sorrel (*Rumex* sp.) reduced appreciably but not completely eliminated. Grazing 5-6 weeks after spraying reduced weeds to a trace (by 80-90 per cent) because the weed killer so weakens the weed stems at ground level that they are broken off by the trampling of grazing animals, and do not grow again. A herbage cut was weighed on plots 1 and 2, before the first grazing, and results are shown below:—

TABLE I—YIELDS OF AIR-DRIED MATERIAL (CWT. PER ACRE)
(Taken Before the First Grazing)

	Cocksfoot	Perennial Rye Grass	WEEDS			Total
			Spurrey	Campion	Others	
Unsprayed	3.5	4.9	6.6	2.3	0.9	9.8
Sprayed ..	6.9	24.7	2.5	0.5		3.0

During the experiment it was observed that high and medium seeding rates, that is, 18-19 lb. and 13-15 lb., gave better cover and growth in competition with unsprayed weeds, than did the low rate of 8-10 lb. The Olsgaard tended to become stemmy and to seed in its first season, even under heavy grazing, and in this respect it does not appear to be so good as S.37 Cocksfoot, which tillers more and does not flower. Neither of the Rye grasses flowered during the season, but observations showed that S.24 is leafier than the Commercial strain.

Good weed control was achieved by using heavy stocking rates, where no spraying was done, and excellent control was obtained with spraying as well. Stocking rates consisted either of 1,500 sheep to the acre or 340 yearling steers for periods of half an hour in the initial grazing to two hours in subsequent grazings. The plots under intensive management were grazed at approximately monthly intervals, the Cocksfoot being grazed three times, the Rye grasses, five times. Under light management two grazings were obtained, and despite more frequent use of the mower, weed control was not so good. The soiling effects of this type of management were noted to be similar to results reported from England and Holland. It is clear that the Rye grasses are far superior to the Cocksfoot on this weedy land. When there is a fair proportion of grass in the weeds, stock will graze them better, and it was noticeable that they grazed the weeds on the Rye grass plots to a much greater extent than those on the Cocksfoot plots, which offered smaller amounts of grass herbage.

The chemical composition of the herbage, excluding weeds, was determined before each grazing, and gave the following results:—

TABLE II—COMPOSITION OF GRAZED HERBAGE
(Per Cent of Dry Matter)

Rye Grass	Stage of Growth	Crude Protein	Crude Fibre	Carbo-hydrate	P ₂ O ₅	CaO
1st Grazing ..	6 inches leaf ..	28	22	32	0·7	0·6
2nd Grazing ..	5-6 inches leaf ..	29	20	33	0·7	0·4
3rd Grazing ..	5-6 inches leaf ..	29	19	32	0·7	0·5
4th Grazing ..	5-6 inches leaf ..	19	20	41	0·5	0·5

The crude protein values are high, phosphoric oxide values are good but calcium values are somewhat disappointing. It should be mentioned that this land was under weed fallow for a season and the high levels of protein may perhaps be reflecting a build-up of soil nitrogen. For comparison, the composition of the grasses cut in their second season, together with the composition of two weeds, is given below:—

TABLE III—THE COMPOSITION OF GRASSES IN THEIR SECOND SEASON
(Per Cent of Dry Matter)

Species	Stage of Growth	Crude Protein	Crude Fibre	Carbo-hydrate	P ₂ O ₅	CaO
Cocksfoot ..	12 inches leaf ..	21	22	39	0·5	0·5
Perennial Rye	7 inches leaf ..	23	21	40	0·5	0·7
Spurrey ..	6-8 inches high	30	14	n.d.	0·8	0·8
Campion ..	4-5 inches high	22	11	38	0·6	1·8

A Study of Methods of Ley Establishment in Weedy Land

In an attempt to compare methods of ley establishment, the time of sowing was considered an important factor, and three sowing dates were selected, namely (a) early sowing, after one weed crop was disced in; (b) middle sowing, with two crops of weeds disced in; and (c) late sowing, with three weed crops disced in. Superimposed on these treatments were: (1) rolling after sowing v. no rolling; (2) top dressing with 1½ cwt. per acre of sulphate of ammonia v. no top dressing; and (3) spraying v. no spraying, on (b) only. The sulphate of ammonia was applied when the grasses were tillering. Each of the following grasses was treated as above: (A) S.23 Perennial Rye grass at 13 lb. per acre; (B) S.143

Cocksfoot at 13 lb. per acre; (C) K.31 Fescue at 14 lb. per acre; and (D) a mixture of (A), (B) and (C) in a 3 : 2 : 1 proportion at 14 lb. per acre. The grasses were sown with 150 lb. per acre of double superphosphate, in 7-in. rows, using an I.H.C., drill.

In considering the results of this trial, the following factors are relevant: weather conditions, soil tilth, weed competition, fertilizers, species of grass, and grazing.

With regard to weather conditions, early sown grass was affected by a long dry spell after germination and this apparently set it back so that fewer grazings than expected were obtained. The only grass to produce well was Perennial Rye grass. For middle and late sowings, the rainfall was adequate, as data in the following table show:—

TABLE IV—RAINFALL FOR 28 DAYS AFTER SOWING

Early sown ..	0.32 inches in 4 rainy days
Middle sown ..	3.89 inches in 11 rainy days
Late sown ..	2.35 inches in 11 rainy days

The general hardness of all three species is demonstrated by their ability to withstand 28 days of drought during establishment.

On the second factor, namely, "tilth", the seedbed for early sown grass received fewer harrowings than the seedbeds prepared for middle and late sowings, and thus lack of adequate tilth may have affected growth. In all probability, the Molo soil requires at least four or five harrowings before grass is sown.

The benefit to the seedbed of the Cambridge roller was assessed by scoring, and results are shown below:—

TABLE V—EFFECT OF ROLLING

	DURING GERMINATION		STAND OF GRASS AT 1ST GRAZING		STAND OF GRASS AT 2ND GRAZING	
	Rolled	Not Rolled	Rolled	Not Rolled	Rolled	Not Rolled
EARLY SOWN—						
Rye Grass ..	G	P	G	P	G	F
Cocksfoot ..	F	P	F	F	F	F
K.31 ..	G	F	F	F	G	F
Mixture ..	F	P	F	F	G	F
MIDDLE SOWN—						
Rye Grass } ..	No visible difference		V.G.	G	G	F.G.
Cocksfoot } ..			No visible difference		No visible difference	
K.31 ..						
Mixture }						
LATE SOWN—						
Rye Grass } ..	No visible difference		No visible difference		G	F.G.
Cocksfoot } ..					No visible difference	
K.31 ..						
Mixture }						

V.G.=Very Good G.=Good. F.G.=Fairly Good. F.=Fair. P.=Poor.

The following conclusions on rolling may be drawn: (1) the effect of rolling is greatest on quick-sowing Perennial Rye grass (See Part II.); (2) the effect during germination is greatest under dry conditions; and (3) the effect is still visible six months after sowing, except for Cocksfoot. In general, the beneficial effects obtained from the use of the Cambridge roller in other countries are confirmed here.

On the factor of weed competition, the dominant weed during the 1953 was *Corrigiola litoralis* ("Litoral weed"), which gave almost 100 per cent ground cover under the "early-sown grasses" treatment. This weed is able to grow under dry conditions (c.f., Weed Germination Study) and is troublesome because of its unpalatability to sheep and cattle. Being prostrate, it is also unmowable. The "middle-sown grasses" were heavily infested with Spurrey, Campion (*Silene gallica*), *Rumex* sp., and *Corrigiola litoralis*, which reduced grass growth considerably. The block sprayed with hormone weed killers was outstandingly better for grass growth than the control, and the effect of spraying was still marked at the end of the year. The following data refer to a herbage cut obtained before the third grazing, that is, four months after spraying.

TABLE VI—EFFECT OF SPRAYING ON YIELD
(Yield in cwt. per acre of air-dried materials)

	Unsprayed	Sprayed*
Rye Grass ..	10.2	18.1
Weeds	7.6	Trace

*Agroxone "3" at 4 pints per acre.

Other commercial weed killers were tried, and relevant details are given in the tables below:—

TABLE VII—STAGE OF GROWTH WHEN SPRAYED

	CAMPION	RUMEX SP.	SPURREY
WEEDS ..	6-leaf	3-6 leaf	2-3 inches high
	K.31 FESCUE	PERENNIAL RYE GRASS	COCKSFOOT
GRASSES ..	2 inches high 0.2 tillers	3 inches high 3-4 tillers	1½ inches high 0.1 tiller

NOTE.—Sprayed six weeks after sowing and grazed one month after spraying.

TABLE VIII—WEED KILLERS USED

No.	Proprietary Name		Pints per acre	Lb. acid eq. per acre
1	Finopal ..	Mixture, Esters of 2, 4-D. and 2, 4, 5-T.	4	3.0
2	Palormone D.	Dimethylamine salt of 2, 4-D.	4	2.5
3	Agroxone 3	Sodium salt of M.C.P.A.	4	1.2
4	Empal ..	(Unknown) M.C.P.A.	4	1.08

Toxic effects of these weed killers were observed in the young grass; No. 1 reduced the take on all plots, Cocksfoot being worst affected. Nos. 2, 3 and 4 produced minor symptoms only. Symptoms of toxicity are stunted and abnormal roots—especially with Cocksfoot—and curly and "onion" leaf. The Finopal produced a weed-free sward; Palormone D and Agroxone "3" were equally good, although there were indications that the former did not control Campion as

effectively as the latter; Empal was the least effective in weed control. It is of interest that despite the damage, an adequate stand of grass was obtained at the comparatively high seed rates used.

In the seedbed preparations for "late-sown grass", three crops of weeds already had been disced in, and it is not surprising that weed control during the two months after sowing, was excellent. This is an easy way of controlling weeds but it suffers from the drawback that the ley is sown comparatively late in the season, with consequent loss of grazing.

As regards fertilizers, the nitrogenous top dressing was effective only on the early sown plots, where the Rye grass responded well. It is likely that the rainfall was insufficient for the other plots to respond similarly.

Of the grass species used in this trial, Perennial Rye grass was outstandingly the best yielder and produced up to four good grazings from the "middle-sown" plots. The Cocksfoot and K.31 grasses, being slow-growing in their first season, produced little. The mixture produced herbage which contained 80 per cent of Rye grass.

Plots were grazed initially by sheep at 480 per acre for $\frac{7}{8}$ -1 hour and thereafter by steers at 200 head per acre. A lower stocking rate was used than in the experiment described earlier, because weed growth was not so dense. This stocking rate, coupled with frequent mowing, gave adequate weed control, though spraying and grazing gave outstandingly the best results.

Effect of Spraying Hormone Weed Killer on Perennial Rye Grass during Establishment, to Control Spurrey

An experiment to observe the effect of spraying a hormone weed killer on S.24 Perennial Rye grass, to control Spurrey, was carried out during the season. It consisted of a randomized block arrangement, with three replications, and the plot size was 450 sq. ft. The treatments were as follows: (1) control; (2) spraying "early" with Agroxone "3" at 2, 4 and 6 pints per acre; (3) spraying "middle", as for (2) above; and (4) spraying "late" with 4 and 6 pints. Spraying was carried out by knapsack sprayer at 60 gal. water per acre and the grass was sown in 7-in. drills at 20 lb. per acre, together with double superphosphate.

TABLE IX—DETAIL OF SPRAYING PERENNIAL RYE GRASS

Stage of Growth	Toxic Effects Two Weeks After Spraying	Final Stand of Grass	Early Spraying			Middle Spraying			Late Spraying			
			9 days after sowing germination not complete. Grass $\frac{1}{2}$ in. high in coleoptile stage.	26 days after sowing 3-4 leaf not quite tillering, $1\frac{1}{2}$ to 2 in. high.	40 days after sowing. 3 in. high with three tillers.	2 pints. Slight reduction in stand.	4 pints. Stand reduced by half.	6 pints. Stand reduced by two-thirds.	2 pints. No effect.	4 pints. Slight reduction.	6 pints. Slight reduction.	2 pints. No observable effects.	4 pints. Good at all rates.
	</											

TABLE X—WEEDS

STAGE OF GROWTH				PER CENT COVER SIX WEEKS AFTER SPRAYING	
Early Spraying	Spurry in cotyledonary stage, germination not complete.	0	80% Spurry dominant, R. & C. common.	23% Spurry dominant, R. & C. rare.	8% Spurry dominant, R. & C. rare.
	No other weeds	4	2%	2% Spurry only.	
	Spurry ½ in. high	0	80% Spurry dominant, R. & C. common.	23% Spurry dominant, R. & C. common.	
	Campion in 2 leaf stage	2	13% Spurry dominant, R. & C. common.	9% Spurry dominant, R. & C. common.	
Middle Spraying	Geranium sp. 5 leaf	4	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.
	Oxalis 2-3 leaf	6	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.
	Spurry 2-3 in. high	0	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.
	Spurry 2-3 in. high	0	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.
Late Spraying	Spurry 2-3 in. high	0	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.
	Spurry 2-3 in. high	0	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.
	Spurry 2-3 in. high	0	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.
	Spurry 2-3 in. high	0	80% Spurry dominant, R. & C. common.	58% Spurry dominant, R. & C. common.	47% Spurry dominant, R. & C. common.

R.=*Rumex* sp. C.=Campion (*Silene gallica*).

Two herbage cuts (72 sq. ft./plot) were taken and weighed. The first cut was obtained 66 days after sowing and the second 35 days after the first cut. Samples each of 2 lb. were analysed botanically into grass and weeds, which were 90 per cent Spurry. The tables below summarize some of the data for the two cuts added together:—

TABLE XI—YIELD OF RYE GRASS (2 CUTS)

(Cwt. per acre air-dried material)

L M E O	2 PINTS	4 PINTS	6 PINTS	C.V. 23%
—	9.02 (100)	19.71 (218)	21.82 (242)	58.70
—	17.17 (190)	22.52 (249)	21.38 (237)	67.01
—	23.11 (256)	20.20 (224)	19.76 (219)	—
	62.43	62.96		

L.S.D. (P, 0.05)=7.93 within the Table.

Figures in brackets are the yields with Control as 100%.

TABLE XII—YIELD OF SPURREY (2 CUTS)

(Cwt. per acre air-dried material)

a O E M L	2 PINTS	4 PINTS	6 PINTS	C.V. 24%	
				—	32.18
—	24.67 (100)	11.99 (49)	5.02 (21)	15.98	32.18
				7.56 (31)	15.98
—	8.32 (34)	4.91 (20)	2.75 (11)	—	—
				11.66 (47)	—
—	—	—	—	15.33	—
				28.56	—

L.S.D. (P. 0.05)=4.26 within the Table.

Figures in brackets are the yields with the control as 100 per cent. When interpreting these and the following figures, it should be remembered that high errors are the rule unless herbage yields are large and that C.V.'s as low as 15 per cent are generally only obtained when the *dry matter* yields are of the order of 20 cwt. per acre. Despite the high errors this experiment shows that S.24 Perennial Rye grass benefits greatly from spraying during establishment; that it had a good tolerance to early spraying under the conditions obtaining; that all the spraying treatments increased grass growth significantly (P.0.05) compared with the controls. All treatments were effective in reducing Spurrey significantly (P.0.05) compared with the controls. The early spraying was obviously too early for optimum control (germination of Spurrey not complete), and the late spraying allowed it to get away. The optimum was the middle spraying (Spurrey 1 in. high) and 4 pints reduced its yield by 80 per cent.

Effects of Pre-sowing Spraying, with Agroxone "3", on Rye Grass Establishment
In order to observe the effects of pre-sowing spraying on ley establishment, an experiment using Agroxone "3" was carried out on a seedbed prepared for Danish Perennial Rye grass on very weedy land. A randomized block layout was used, and each treatment replicated four times. The plot size was 30 ft. by 15 ft., and each plot was sub-divided into three sub-plots each 30 ft. by 5 ft. There were three control plots per replicate. Treatments were as follows: (1) control; (2) spraying at 2, 4 and 6 pints Agroxone "3" per acre, on the seedbed before sowing the grass; and (3) sowing. In each set of sub-plots, the grass was sown early, middle and late. Early sowing was done 7 days after spraying, middle sowing 16 days after spraying, and late sowing 2 months after spraying. The spraying was carried out from a knapsack sprayer at 60 gal. water per acre. The grass was drilled by Planet Junior, using a seed rate of 20 lb. per acre, and double superphosphate was applied to the seedbed.

A score for germination on the early sown sub-plots showed considerable reduction in stand 14 days after sowing. Seedling counts were therefore made from 2-ft. by 20-ft. rows, at random, and the following data obtained:—

TABLE XIII—SEEDLING COUNTS

TREATMENT	Mean No. of Seedlings per Plot	Seedlings per Foot
0	535.6	13
2 pints	500	12
4 pints	486.25	12
6 pints	252.5	6.3

L.S.D. (P. 0.01) for Control v. treatments=123.5
L.S.D. (P. 0.01) between rates=151.9

The 6-pint rate has therefore significantly fewer seedlings than the control and 2- and 4-pint rates. No reduction in germination was observed with the middle and late sowings.

On each sub-plot, an area of 90 sq. ft. was cut by motor scythe and the herbage sampled for weeds and grass. In considering the yield data shown below, a strict comparison between times of sowing is not possible because of different sets of weather conditions at and after each time of sowing. In particular the middle sowing came with a long dry spell which reduced the grass take considerably, and which affected the yields obtained.

TABLE XIV—PERENNIAL RYE GRASS IN ONE HERBAGE CUT (MEANS)

(Cwt./acre air-dried material)					
RATES	TIME OF SOWING			Means	Not significant.
	Early	Middle	Late		
	0	4.54	1.30			4.66	3.50
2	7.13	1.73	5.70	4.85	}
4	7.13	3.02	4.54	4.89	
6	4.32	1.81	4.62	3.58	
	6.16	2.15	4.95		

L.D.S. Controls v. Rates at same time=1.94 (P. 0.05).
L.D.S. Between Rates at same time=2.38 (P. 0.05).
C.V. Whole plots 20%.

It may be concluded that 2- and 4-pint results in significantly (P.0.05) more grass when sown early, compared with the control. The 6-pint level decreased the early sown grass significantly compared with 2 and 4 pints (of seedling counts). No significant results were obtained with the middle and late sowings, though the 4-pint middle sowings approach significance. The lack of significance in the late sown grass, which had adequate rainfall, may be interpreted to mean that the weed killer no longer was effective in the soil, even at 6 pints per acre.

TABLE XV—WEEDS IN ONE HERBAGE CUT (MEANS)

(Cwt./acre air-dried material)					
RATE	TIME OF SOWING			Mean	L.S.D. (P. 0.05)
	Early	Middle	Late		
	0	14.69 (100)	17.24 (100)			13.61 (100)
2 4 6	11.75 (80)	9.50 (55)	13.61 (100)	11.62	} L.S.D. (P. 0.05) 3.15.
	12.31 (83)	7.77 (45)	10.02 (74)	10.03	
	7.77 (53)	4.10 (24)	7.22 (53)	6.36	
	10.61	7.12	10.25		
Control mean v. Rate Means 2.5.					

L.S.D. (P. 0.05) Control v. Rates at same time=2.59.
L.S.D. (P. 0.05) Between two rates at same time=3.63.
C.V. Whole plots 10%.

Control mean
v. Rate Means
2.5.

It may be concluded from the overall means that all rates of spraying were effective in reducing weed growth, and that the 6-pint level is more effective than the lower rates. Between times, all except 3 early, and 2 and 4 late have significantly fewer weeds than the controls; the former is probably a chance result. It is of interest that 6 pints was still effective in reducing weeds 2 months after spraying, although no effect on grass growth was evident.

The dominant weeds in this experiment were *Geranium* sp. (80 per cent) and Campton (10 per cent) with small amounts of *Rumex* sp., *Corrigiola littoralis* and Mayweed. Their susceptibilities are noted below:—

TABLE XVI—WEED SUSCEPTIBILITIES

RATE	2 pints			Mayweed	Campton	Rumex sp.			Geraniumsp.
	..	4 pints	6 pints			R	S	V.S.	
	..	..	..	R	R	R	S	V.S.	R
	..	..	..	S	S-R	R	S	V.S.	R
	..	..	..	V.S.	V.S.	R	R	R	R

V.S. Very susceptible.

S. Susceptible.

R. Resistant, but reduced in growth.

The data from this experiment indicate that Perennial Rye grass may be sown one week after the pre-sowing spraying at 2-4 pints per acre with beneficial results (157 per cent increase in yield), with a 20 per cent decrease in weeds.

Effects of Spraying Hormone Weed Killer on Cockfoot during its Establishment in Weedy Land

The effects of spraying hormone weed killer were tested also on Danish Cockfoot establishment, in weedy land. The experiment was arranged in randomized blocks and there were three replications. The plot size was 18 ft. by 30 ft. The treatments used were: (1) control (three per block); and (2) spraying with Agroxone "3" at 2, 4 and 6 pints per acre, applied early, middle and late. Plots were sub-divided for top dressing at $1\frac{1}{2}$ cwt. per acre of sulphate of ammonia, versus no top dressing. Spraying was carried out by Knapsack sprayer at 60 gal. water per acre, and the grass was drilled in 7-in. rows at 9 lb. per acre, together with 145 lb. of double superphosphate per acre.

Some of the spraying details are summarized in the table below:—

TABLE XVII—SPRAYING DETAILS

Time of Spraying	Days After Sowing	Stage of Grass	Stage of Weeds
Early ..	6 weeks ..	2 in. high. Four leaf or over. Tillerling just starting.	<i>Rumex</i> dominant. 6-7 leaves. Spurey 2 in. to 3 in.
Middle ..	7½ weeks ..	3 in. high. Tillerling well with two tillers.	<i>Rumex</i> sp. dominant. 8-leaf and Spurey to 4 in. high.
Late ..	9½ weeks ..	3 in. high. Well tillered.	Weeds 2 in. to 4 in. high. Spurey to 8 in. high.

The following results are based on one herbage cut which was sampled and analysed botanically for weeds and grass. Before the herbage cut there was, however, one clearance cut of weed growth nine weeks after sowing which was not weighed. The yield figures for weeds in the herbage cut will accordingly show less response to spraying than would be expected. The herbage cut was made two months after the clearance cut and two months after the top dressings were applied. In considering the results the late spraying was too late and no responses noted, and so they have been omitted from the tables.

TABLE XVIII—YIELD OF COCKSFOOT IN ONE HERBAGE CUT

(Cwt./acre air-dried material)

Rate	No Top Dressing	Top Dressed	Rate Means	L.S.D.'s (P. 0.05).	
				Control mean v. Spray means=2.92.	Between spray means=3.56.
0	2.65 (100)	5.99 (100)	4.32 (100)	12.01 (277)	11.36 (262)
4M	4.91 (180)	19.11 (318)	12.01 (277)	7.39 (181)	6.48 (150)
2M	5.45 (238)	9.34 (155)	7.39 (181)	4.69 (108)	3.88 (90)
2E	3.35 (126)	9.61 (160)	6.48 (150)	Between Controls T.D.v.NoT.D.=2.75.	Between sprays at same T.D. level=4.91.
4E	3.13 (118)	6.26 (104)	3.88 (90)		
6E	3.83 (144)	3.94 (65)			
Mean ..	4.76	10.52		Whole plot C.V. 22%.	

L.S.D. (P. 0.01) between means of sprays Top Dressed v. No. T.D.=2.43.

The main conclusions to be drawn are: (1) comparing rate means with the control, all the middle spraying treatments produced significantly more grass. It is evident that the early spraying at all except 2 pints hindered grass growth; (2) comparing sprays at the same top dressing level with the control, no significant differences are observed, although the general trend indicates that the middle spraying is best. With top dressing, the 4- and 6-pint levels are significantly better than the controls except when sprayed early. A significant interaction was found between time of spraying x T.D., and the fact that early spraying with top dressings tends to reduce grass yield obviously needs further study. In general, one may conclude that spraying should not be done earlier than 7½ weeks after sowing, when the grass has about 2 tillers, and that 4 pints is an adequate rate; the effect of top dressing is most marked under the above conditions.

TABLE XIX—YIELD OF WEEDS IN THE HERBAGE CUT

(Cwt./acre air-dried material)

Rate	No Top Dressing	Top Dressed	Rate Means	L.S.D.'s (P. 0.05)	
				Control mean v. Rate means=3.56.	Between rate means=4.37.
0	16.68 (100)	20.25 (100)	18.46 (100)		
6M	6.64 (40)	6.97 (34)	6.80 (37)	10.17 (55)	12.69 (69)
4M	11.93 (71)	8.42 (41)	10.17 (55)	13.63 (74)	13.68 (74)
2M	11.66 (70)	13.72 (68)	12.69 (69)	Sprays v. Control at same. Top dressing level=5.89.	
2E	13.72 (82)	13.55 (67)	13.63 (74)		
4E	12.74 (76)	14.63 (72)	13.68 (74)		
6E	13.66 (82)	17.55 (87)	15.60 (84)		
Mean ..	11.72	12.47		Whole plot C.V. 14.4%.	

Despite the weeds having been cut once before the herbage was cut, the effect of spraying is still visible. Top dressing did not stimulate weed growth significantly either sprayed or unsprayed. All sprays, except for the 4 pints early, were effective in reducing weed growth significantly.

The fact that middle sprayings were more effective than early might be explained by reference to a weed germination study. This study showed that a spate of germinations occurred from 10th June onwards and this germination coincided with the middle spraying (on 17th June, 1953). Few weeds were germinating when early spraying was done (4th June, 1953). One may conclude that under these conditions 4 pints middle was the most effective spray, and this is confirmed by grass yields.

Effects of Weed Killers on Growth of Italian Rye Grass in Spurey Infested Land

In this observational experiment, in which scoring was done visually, the effects of various weed killers on the growth of Italian Rye grass, was studied. The land prepared for the grass was heavily infested with Spurey. A summary of the main details and results of the trial is tabulated below:—

TABLE XX—EFFECT OF VARIOUS WEED KILLERS ON ITALIAN RYE GRASS ESTABLISHMENT

Effective-ness	Weedkiller	Pints p.a.c.	Lb./Acid eq./acre	Effect on Spurey	Effect on Final Stand of Grass
1	Finopal ..	8	80-90% cover of Spurey. Fair control. No ill effects.	5% survival only.	Reduced by 80%, but final stand still good.
2	Finopal ..	6		Spurey occasional effects.	No observable ill-effects.
3	Agroxone 3 ..	4		Spurey occasional effects.	No observable ill-effects.
4	Finopal ..	4		Spurey occasional effects.	No observable ill-effects.
	Palormone D. ..	4		Spurey occasional effects.	No observable ill-effects.
	Empal ..	4		Spurey occasional effects.	No observable ill-effects.
	Finopal ..	2		Spurey occasional effects.	No observable ill-effects.
	Control ..	0		Spurey occasional effects.	No observable ill-effects.
	Agroxone 3 ..	2		Spurey occasional effects.	No observable ill-effects.
	Empal ..	2		Spurey occasional effects.	No observable ill-effects.
	Palormone D. ..	2		Spurey occasional effects.	No observable ill-effects.
	Finopal ..	2		Spurey occasional effects.	No observable ill-effects.

Spraying was done by knapsack sprayer (72 gals. water/acre) one month after sowing. The Rye grass was 2 in. high in the 3-4 leaf stage just before tillering; the Spurey was 1 to 1½ in. high. The economic range lies between 2 and 3 pints.

Effect of Hormone Weed Killers on Perennial Rye Grass Establishment in Weedy Land

An observational experiment on the use of hormone weed killers in establishing Perennial Rye grass on very weedy land, took the form of a randomized block, with two replications of each of the following treatments: (1) Palormone D, sprayed at 0, 2, 4, 6 and 8 pints per acre; (2) Empal, sprayed at 0, 2, 4 and 6 pints per acre; and (3) Finopal, sprayed at 0, 2, 4 and 6 pints per acre. Spraying was carried out, as usual, by knapsack sprayer when the grass was: (a) 2 in. high, had 3-6 leaves and was not tillering; and (b) 3 in. high and tillering.

Recording was done by scoring and observation only and the effects on the Rye grass, six months after treatment, are tabulated below:—

TABLE XXI—EFFECTS ON PERENNIAL RYE GRASS SIX MONTHS AFTER SPRAYING

WEEDKILLER	RATE	TIME OF SPRAYING	
		(a) Early	(b) Late
Finopal	6	Good stand.	Very good stand.
	4	Very good stand.	Very good stand.
	2	Very good stand.	Good stand.
	0	Very poor.	Very poor.
	8	Very good stand.	Very good stand.
	6	Very good stand.	Very good stand.
Palormone D. ..	4	Very good stand.	Very good stand.
	2	Very good stand.	Very good stand.
	0	Very poor.	Very poor.
	8	Very good stand.	Very good stand.
	6	Very good stand.	Very good stand.
	4	Very good stand.	Very good stand.
Empal	2	Fair to poor.	Fair to poor.
	0	Very poor.	Very poor.
	6	Good to very good.	Good.
	4	Fair to good.	Good.
	2	Fair to poor.	Fair.
	0	Fair.	Fair.

With Palormone D, toxic effects were noted in the early spraying at the 6- and 8-pint rates. With Finopal, the 6-pint application produced a similar reduction in grass take, but the final stand was adequate. No adverse effects were seen with the late sprayings. The best economic rates of spraying appear to be 2 pints of Finopal, applied early, 4 pints of Palormone D, applied early, and 4-6 pints of Empal.

TABLE XXII—EFFECTS ON WEEDS

A score (0-5) six months after spraying showing the following:—

WEEDKILLER	SPRAY RATE AND TIME						
	O	6E	6L	4E	4L	2E	2L
Finopal	5	1	0	1	1	1	5.5
Palormone D. ..	5	1-3	2	2	1	5	16.5
Empal*	4-5	1-3	1	3-4	2-3	4	16
Total							

* 20 per cent fewer weeds on this experiment than the others.

The dominant weed in this experiment was *Rumex* sp. Very little Campton or Spurley had germinated when the sprayings were done.

Effects of Pre-sowing Spraying on Establishment of Cocksfoot in Weedy Land

In an experiment to observe the effects of pre-sowing spraying weedy land on the establishment of Olsgaard Cocksfoot, four replications of the following treatments were arranged in randomized blocks: (1) plots 30 ft. by 15 ft were sprayed with Agroxone "3" at 2, 4 and 6 pints per acre; (2) sub-plots, 30 ft. by 5 ft., were sown early, middle and late, by Planet Junior, at 15 lb. seed per acre. In

each of the four replicates, there were three control plots. Early sowing took place one week after spraying, middle sowing two weeks after spraying and late sowing seven weeks after spraying.

The middle sowings suffered from dry weather, and the late sowings had to be delayed to seven weeks because of lack of rain.

A seedling score of early sowings showed a reduced germination so seedling counts were done on early plots one month after sowing with the following results:—

<i>Treatment</i>	<i>Seedling Nos.</i>	<i>Seedling/foot</i>
0	869	21.7
2 pints	710	17.7
4 pints	662	16.5
6 pints	600	15.0

The difference between the control and 6-pint level is significant ($P<0.05$). The Cockfoot is a slow grower and these figures are an underestimate of the reduction in seedling numbers, as it was not possible to do a later count because of the heavy weed growth on control plots. In fact, the final stand of grass on the 6-pint plots was very patchy, although growth of the surviving plants was good. No reduction in take was observed in the middle and late sowings. Analysis of the figures of a weed clearance cut showed that the 4- and 6-pint levels for the early sowings reduced the weeds significantly, while the 6-pint level for the late sowings was still significantly effective in reducing weeds four months after spraying.

The figures for yields of herbage are tabulated below. Lack of rains resulted in there being very little yield on late sown plots, so these were not cut and are excluded from the summary of results. A 72-sq. ft. sample was cut on each sub-plot by hand sickle, and a 2-lb. fresh weight sub-sample taken for botanical analysis and drying. The calculations below refer to gm. air-dried material in each 2-lb. sub-sample.

TABLE XXIII—OLSGARD COCKSFOOT

(Mean yield in gm. air-dried material in 2-lb. sub-sample)

Rate	Early Sown	Middle Sown	Rate Mean
0	64.0	16.1	40.0
2	94.7	41.0	67.8
4	130.2	55.5	92.8
6	133.7	45.7	89.7
Mean	186.2	47.4	Whole plot C.V. 14%

L.S.D. ($P<0.01$) Control mean v. Rate means=20.6.
L.S.D. ($P<0.05$) between Rate means=18.4.
L.S.D. ($P<0.05$) between Sprays at same time=27.0.

Sowing one week after spraying at 4 pints per acre would seem an economic proposition.

TABLE XXIV—YIELD OF WEEDS IN THE HERBAGE CUT
(Gm. air-dried material in 2-lb. fresh weight)

Rate	Early Sown	Middle Sown	Rate Means
0	207	257	232
2	202	225	214
4	144	198	171
6	148	180	164
Mean	164.9	201	Whole plot C.V.=6%

L.S.D. (P. 0.05) Control Mean v. Rate means=25.

L.S.D. (P. 0.05) between two Rate means=28.

L.S.D. (P. 0.05) between Rates at same time=35.

Under these conditions the 4-pint level seems the best. The dominant weeds in this experiment were Spurrey (80-90 per cent) and Campion (10-20 per cent). It was noticeable that while this type of spraying reduced the numbers of Spurrey plants growing it did not reduce the growth in height nearly so much as did the post-emergent spraying.

Effect of Spraying Hormone Weed Killer on Establishment of a Cockfoot-K.31 Fescue Mixture in Weedy Land

The effect of spraying the hormone weed killer, Agroxone "3", on the establishment of a Cockfoot-K.31 Fescue mixture on weedy land also was studied. Using a randomized block design, with three replications, and two control plots per block, Agroxone "3" was sprayed at four rates, namely, 0, 2, 4 and 6 pints per acre. The grass seed was drilled in 7-in. rows at 18 lb. per acre—9 lb. S.37 Cockfoot and 9 lb. K.31 Fescue—and 170 lb. of double superphosphate was placed with the seed. Spraying details are given in the tables below:—

TABLE XXVa—VERY EARLY SPRAYING (14 DAYS AFTER SOWING)

Stage of Grasses	Stage of Weed Growth	Toxic Effects on Grasses Nine Weeks After Spray	Final Grass Stand
K.31. Still germinating, coleoptile stage. Cockfoot, not yet germinating.	Spurrey, Campion and Geranium in cotyledonary stages.	Six pints reduced the take of both grasses. Four pints, minor effects on K.31 only, two pints no symptoms.	Good, even at six pints.

TABLE XXVb—EARLY SPRAYING (24 DAYS AFTER SOWING)

Stage of Grasses	Stage of Weed Growth	Toxic Effects on Grasses Six Weeks after Spray	Final Stand of Grass
K.31. 2 leaf stage. Cockfoot. 2 leaf stage.	Spurrey 1 in. high. Campion 4 leaf.	Six pints affected both grasses slightly. Four pints affected Cockfoot only slightly. Two pints no symptoms.	Good, even at six pints.

Two herbage cuts were made. The first, which is not reported here in detail, showed that even the high rate of very early spraying was beneficial, and that grass yields were markedly improved by the reduced weed competition obtained. There was between two to three times more Fescue than Cocksfoot in this cut. The second cut figures are shown below. These show the yield in gm. air-dried material from a 2-lb. fresh weight sample taken from the total sample yielded by 72-sq. ft. cut on each plot.

TABLE XXVI—TREATMENT MEANS

TREATMENT	(Gm. air-dried material)	
	Grass (Cocksfoot and Fescue)	WEEDS
0	53.7	225.3
2 Very Early. 6 Very Early.	83.3	208.3
2 Early.	89.3	206.6
4 Early.	111.0	204.6
4 Very Early.	126.3	169.3
6 Early.	138.3	141.3
6 Very Early.	183.3	129.6
L.S.D.	Control v. Treatments 47.7	Control v. Treatment = 51.9
L.S.D. (P. 0.05)	Between Treatments 55.0	Between Treatments = 59.9

These results indicate that though the very early spraying tended to reduce grass yield compared with the early spraying, even so they were better than the controls. The effect of spraying on weed yields is largely obscured by the first cut. In the first cut the proportions by weight of weeds present were 15 per cent Campion, 85 per cent Spurrey. In the second cut, 70/80 per cent Campion, 20 per cent Spurrey. The proportions by weight of Cocksfoot to Fescue in the second cut were 53 : 47.

Effect of Spraying Hormone Weed Killer on K.31 Fescue Establishment in Weedy Land

The value of Empal as a weed killer was tested on K.31 Fescue. In a randomized block experiment, with two replications and two control plots per block, spraying with Empal was carried out early and late, at 0, 2, 4 and 6 pints per acre. Spraying was done by knapsack sprayer at 60 gal. of water per acre. The Fescue was drilled at 9 lb. per acre in 7-in. rows, together with double super-phosphate applied at 180 lb. per acre. Each plot was 18 ft. by 25 ft.

Spraying details are summarized below :—

TABLE XXVII—DETAILS OF SPRAYING WITH EMPAL

Late	Early	Toxic Effects on Grass			
		Time of Spraying	Stage of Grass	Stage of Weeds	
Five weeks after.	Two weeks after sowing.	Coleoptile stage, germination not complete.	Cotyledon stage, Campion dominant, Spurrey common.	Six pints reduced grass take but final stand adequate. Four pints minor effects only.	No observable effects.
2-3 leaf 2 in. high.	Campion 5 leaf. Spurrey 2 in. high.				

Two herbage cuts were taken, the first nine weeks and the second 22 weeks after sowing. The first cut was analysed into Fescue, Spurrey and other weed fractions (90 per cent Campion), the second into Fescue and total weed growth (90 per cent Campion), and the tables below summarize the data:—

TABLE XXVIII—FIRST HERBAGE CUT

(lb. air-dried material per acre)

Treatment	Fescues	Spurrey	Other Weeds (90% Campion)
0	33.25	993.7	659.4
2 pints Early	42.35	284.3	187.5
4 pints Early	81.65	117.9	81.6
6 pints Early	72.55	60.5	60.4
2 pints Late	42.35	353.9	290.4
4 pints Late	39.30	680.6	220.8
6 pints Late	33.25	223.8	93.7
L.S.D.'s	Control v. Treatments =13.12	Control v. Treatments =179.2	Control v. Treatments =204.6
(P. 0.05)	Between Treatments =15.15	Between Treatments =207	Between Treatments =236.2

(Yield in gm. air-dried material in 2-lb. Fresh weight sub-sample)

TABLE XXIX—SECOND HERBAGE CUT

Treatment	Fescue	Total Weeds (90% Campion)
0	10	255.5
2 pints Early	24	258
4 pints Early	51	230
6 pints Early	63.5	211
2 pints Late	15	283.5
4 pints Late	24	273.5
6 pints Late	33.5	237
L.S.D.'s	Control v. Treatments=20.1	Not significant.
(P. 0.05)	Between Treatments=23.1	

It may be concluded that early spraying is better than late spraying and that Campion proved more resistant.

Fertilizer Experiment on Lucerne

An experiment to study the effect of lime, potash, sulphate of ammonia and superphosphate on Lucerne was laid out in 1952, using a 2⁴ design, with two replications. This year, fresh weight yields of herbage were obtained, and it will be seen from the yield data given in the table below that under the conditions of this experiment, there is a marked L and P interaction:—

TABLE XXX—L AND P INTERACTION

(lb. fresh lucerne per plot)

	-P	+P	Mean
-L	11.0	12.5	11.7
+L	15.9	26.1	21.0
Mean	13.4	19.3	

The vigour of the Lucerne on all plots receiving both lime and phosphate was markedly different from remaining plots. The former grew well, with large leaves and little leaf spot, the latter produced small leaves which spotted and shed easily.

Before fertilizers were applied in August, 1952, the soil's mean pH value was 5.06. In February, 1954, the mean value was 5.09. The effect of lime on soil reaction may be seen, however, from data given in the table below:—

TABLE XXXI—EFFECT OF LIME ON SOIL PH (FEBRUARY, 1954)

	-P	+P	Mean
-L	4.52	4.64	4.58
+L	5.80	5.40	5.60
Mean	5.16	5.02	

This experiment will be reported in greater detail next year.

Rye Grass as a Weed

A collection was made of a stemmy type of Rye grass which now grows naturally in the district to the extent of becoming a pest in arable land. Seed was collected from three sites and sown in the nursery. Seed was also sown of once-grown and original "Wimmera" Rye grass. Observations during the season showed that the wild stemmy Rye grass is undoubtedly "Wimmera" Rye grass. It is recommended that this grass should not be used as a ley grass in view of its high seeding qualities and potential rapid spread to arable land.

Co-operative Experiments

No outside work was undertaken because of call up of staff to the Security Forces.

General Summary of the Years' Results

Field establishment trials produced useful data which will need further confirmation. The outstanding grasses for quick growth and good yields in competition with weeds were undoubtedly the Perennial Rye grasses; these, however, dry off fairly quickly after the rains. *Phalaris tuberosa* and the Cockfoot on the other hand remain green much longer (still green in March, 1954). It is probable that a ley system using these two types of grass (early growers and late growers) will be found useful in extending the grazing season. Even so, it is likely that silage and hay will have to be found for three months every year for high-producing stock.

1953 was a year of limited rainfall and the results of the spraying trials probably reflect the competition for soil moisture more markedly than would be so in a normal year. The warm weather was ideal for producing effects from hormone weed killers and the effects noted need confirmation under more normal conditions, particularly so in respect of the reactions of grasses to early spraying. The absence of a good legume will be noticed in the above results. This aspect will be tackled in 1954 when seed of some indigenous clovers will be available for small field trials.

Acknowledgments

The loan of sheep and cattle by Mr. T. Ryan is gratefully acknowledged, without whose help no grazing trials would have been carried out.

The good work of the African staff made the programme possible.

REPORT OF THE PASTURE RESEARCH CHEMIST (H. W. DOUGALL)

An Attempt to Improve a Wormout Kikuyu Grass Pasture

Study of a degenerate Kikuyu grass pasture on the South Kinangop showed that the soil is ineffectively aerated, acid in reaction and of extremely low plant-nutrient status. It carries a mat of roots and undecomposed plant residues and the vegetation is usually of poor grazing value (*E.A. Agricultural Journal*, vol 19, 1953). It is considered that to bring about improvement, the turf horizon must be broken up mechanically by "ripping" or by ploughing it under, and nutrient deficiencies in the newly aerated soil must be corrected by applying appropriate plant foods. These methods of improvement were tested on Mr. J. F. Lipscomb's farm on the South Kinangop. Analyses of the unimproved soil are given in Table I.

In the experiment there were two blocks of 15 plots, each plot measuring 100 ft. by 30 ft. In each block there were three rows of five plots. Alternate rows received the following mechanical cultivations: (i) no cultivation; (ii) the turf was ploughed out with a mouldboard plough and disc harrowed to give an even surface; and (iii) the turf was ripped repeatedly with a two-ganged disc harrow until topsoil became exposed.

Fertilizers were applied as top dressings to the five plots of each cultivation treatment as follows: soda phosphate and sulphate of ammonia; superphosphate and sulphate of ammonia; guano and sulphate of ammonia; rock phosphate and sulphate of ammonia. One ploughed plot and one ripped plot in each replicate received lime, superphosphate and sulphate of ammonia. Each plot remaining in each replicate was left uncultivated and received no fertilizers.

Rates of application for fertilizer phosphates were adjusted to provide a dressing equivalent to 54-60 lb. citric soluble P_2O_5 per acre and fertilizer nitrogen provided the equivalent of 30 lb. nitrogen per acre. Lime, containing 47 per cent CaO , was applied at a massive rate equivalent to 5 tons CaO per acre, that is, three times the amount necessary to bring the soil pH to a value of 7 in the laboratory.

After ploughing, the grass soon reappeared in rows and bore a resemblance to a young cereal crop: 10 weeks after mechanical treatment and fertilizer application, all plots were grazed by a dairy herd of 23 head. Immediately before the herd had access to the plots, herbage samples were obtained for chemical analysis (Table II). The data obtained showed clearly that ploughing out, fertilizing and allowing natural regeneration produced herbage rich in crude protein and carotene and low in fibre. On the other hand, ripping appeared not to affect these components to any extent. The phosphoric oxide content of herbage from ploughed plots was increased by fertilizer phosphorus, especially in the form of soda phosphate or of guano, and in the presence of nitrogen. The percentage lime content of the herbage was largely unaffected by fertilizers, except on ploughed plots where lime and superphosphate were used together with nitrogen.

TABLE I—SOIL ANALYSIS

Exchangeable Bases M.E. per 100g. Soil	Ca	Mg.	K ..	T.E.B.	pH	P ₂ O ₅ (p.p.m.)— In acid sol. ..	Adsorbed ..	Acid sol + adsorbed ..	% Carbon ..	% Nitrogen ..	Ratio C : N ..
8-16 in.	1.13	0.60	0.68	2.5	5.7	5	5	87	4.01	0.26	20.0
4-8 in.	2.30	1.06	0.63	4.1	5.3	5	16	14	4.05	0.29	18.3
0-4 in.	2.13	1.65	1.08	5.2	5.3	2	20	114	..	..	..

Experience this year showed that for "ripping" to have any effect on mat destruction, it must be carried out on several occasions, and for this reason it is not likely to have practical appeal. On the other hand, ploughing offered certainly the quickest and probably the most effective means of attending to mat destruction and soil aeration, and creating a new and more vigorous sward. At the time of ploughing it is desirable to endeavour to correct known soil deficiencies, especially as regards phosphate. From the evidence available, choice of fertilizer phosphorus might well be decided on a basis of relative cost per unit of citric-soluble P₂O₅, and an adequate dressing of the form selected would be 54-60 lb. citric-soluble P₂O₅ per acre. A readily assimilable source of nitrogen is desirable and the use of sulphate of ammonia to supply 30 lb. of nitrogen per acre is advocated.

The phosphoric oxide content of all herbage was enhanced markedly by all forms of fertilizer phosphates irrespective of cultivations; in particular, the guano and the rock phosphate treatments promoted very high P₂O₅ values. The percentage lime content of the herbage continued to be improved by the lime applied and values obtained with rock phosphate showed that the lime contained in the mineral phosphate was becoming available for plant growth.

Plots other than controls received a second dressing of fertilizer nitrogen and regrowth herbage was sampled for chemical analysis (Table III) later in the season, immediately before again allowing the dairy herd access to the plots. On this occasion, herbage from all uncultivated plots contained less protein than corresponding plots which were cultivated and was slightly more fibrous. For crude protein, the lime, superphosphate and nitrogen treatment failed to maintain the superiority over other treatments which it showed in the first cut, at a time when the control value was also high: indeed, it was markedly lower. The superphosphate and nitrogen treatment also gave a crude protein value inferior to those obtained with soda phosphate, with guano, or with rock phosphate and nitrogen.

TABLE II—COMPOSITION OF SOUTH KINANGOP HERBAGE (FIRST CUT)
(Results based on 100 per cent dry matter)

CONSTITUENT	CULTIVATION	FERTILIZER					
		SULPHATE OF AMMONIA AND					
		Lime and super-phosphate	Rock phosphate	Guano	Super-phosphate	Soda-phosphate	None
Ash	None	—	10.46	10.85	10.38	10.19	10.38
Crude Protein ..	Plough	10.61	12.59	15.66	12.39	14.11	14.11
..	Rip ..	9.89	11.17	10.48	9.46	9.81	9.81
..	Plough	—	9.17	8.94	9.10	10.31	10.31
..	None	—	10.46	10.85	10.38	10.19	10.38
Ether Extract ..	None	3.59	3.89	3.65	3.55	3.54	3.55
..	Rip ..	—	4.02	3.82	3.74	3.65	3.65
..	Plough	4.22	3.97	2.78	3.50	3.91	3.91
Carbo-hydrate	None	45.22	49.84	46.52	49.05	47.59	47.59
..	Rip ..	43.55	46.31	46.88	49.10	47.83	47.83
..	Plough	—	44.56	46.68	49.00	45.97	45.97
Crude Fibre ..	None	23.45	23.22	23.32	24.63	24.57	24.57
..	Rip ..	20.67	23.68	23.35	24.29	24.74	24.74
..	Plough	—	20.73	20.34	21.53	21.35	21.35
P ₂ O ₅	None	0.63	0.67	0.64	0.64	0.67	0.67
..	Rip ..	—	0.61	0.69	0.66	0.57	0.57
..	Plough	0.69	0.64	0.80	0.68	0.83	0.83
CaO	None	—	0.79	0.73	0.56	0.72	0.72
..	Rip ..	0.69	0.63	0.73	0.56	0.57	0.57
..	Plough	0.85	0.69	0.62	0.70	0.73	0.73
Carotene mgm. Per kilo.	None	—	220	266	258	252	252
..	Rip ..	262	221	220	253	221	221
..	Plough	179	250	305	285	353	353

CONSTITUENT	CULTIVATION	FERTILIZER					
		SULPHATE OF AMMONIA AND					
		Lime and super-phosphate	Rock phosphate	Guano	Super-phosphate	Soda-phosphate	None
Crude Protein ..	None	—	15.49	15.03	14.32	17.90	17.90
..	Rip ..	16.13	19.09	19.75	17.75	19.26	19.26
..	Plough	14.71	18.08	21.11	17.83	21.36	21.36
Crude Fibre ..	None	—	28.47	26.81	27.22	26.89	26.89
..	Rip ..	26.23	24.69	25.17	25.81	26.02	26.02
..	Plough	24.23	25.68	24.78	25.45	24.01	24.01
P ₂ O ₅	None	—	1.08	0.90	0.95	0.71	0.71
..	Rip ..	0.79	1.03	0.91	0.86	0.99	0.99
..	Plough	0.86	1.00	0.94	0.84	0.86	0.86
CaO	None	—	0.88	0.65	0.74	0.65	0.65
..	Rip ..	0.76	0.83	0.63	0.61	0.70	0.70
..	Plough	0.66	0.93	0.71	0.71	0.63	0.63

Effect of Ammonium and Nitrate Nitrogen on a Temporary Molasses Grass Pasture

On the Grassland Station at Kitale, nitrate of soda and sulphate of ammonia, each supplying the equivalent of 18 lb. and 36 lb. nitrogen per acre, were compared in a field experiment on a temporary Molasses grass pasture to which a basal dressing of double superphosphate, supplying the equivalent of 80 lb. P_2O_5 per acre, had first been given. The pasture had been established two years previously in a coarse sandy loam soil of pH 5.8. All treatments were replicated five times.

The data given below show that the nitrogen content of Molasses grass increased with the amount of nitrogen applied and corresponding amounts of ammonium and of nitrate nitrogen produced almost identical values for percentage nitrogen contained in the herbage. Clearly, the grass made better use of ammonium nitrogen, for yields of dry matter are significantly higher with sulphate of ammonia than with nitrate of soda.

The percentage P_2O_5 content of the herbage was increased significantly by both nitrogenous fertilizers. There was no significant difference between the two forms of nitrogen although ammonium nitrogen gives slightly higher P_2O_5 values than nitrate nitrogen.

These results accord with those obtained by Lewis, in England (*Journ. Agric. Science*, vol. 26, 1936), when he compared the effects of ammonium and nitrate nitrogen on Perennial Rye grass growing in a sand-bentonite medium of pH 7.61. He found the percentage phosphoric oxide content of the Rye grass was lower with nitrate nitrogen than with ammonium nitrogen, and also that nitrate nitrogen was less effective than ammonium nitrogen in increasing yields of dry matter.

Soil reaction values were determined before fertilizers were applied and after the grass was harvested. After harvesting, the nitrogenous fertilizers were applied again and pH values were determined late in November, that is, nearly six months later. Results, which are given below, show an increase in acidity with the ammonium fertilizer and a decrease with nitrate fertilizer.

TABLE IV—YIELDS OF HERBAGE AND PERCENTAGE N AND P_2O_5 CONTENT

FERTILIZER	TREATMENT MEANS				
	Nitrogen per cent Dry matter	Yield of Dry matter Tons per acre	P_2O_5 per cent Dry matter	Yield (lb. per acre) Cr. Pro.	P_2O_5
No nitrogen	1.151	1.13	0.44	181	11
SUL. OF AMMONIA—					
18 lb. N. p. acre ..	2.249	2.06	0.64	647	29
36 lb. N. p. acre ..	2.681	1.92	0.61	720	26
NITRATE OF SODA—					
18 lb. N. p. acre ..	2.120	1.68	0.56	497	21
36 lb. N. p. acre ..	2.640	1.30	0.58	479	17

	Yield of Dry Matter	% P ₂ O ₅ in Herbage
S.E. of difference between Controls and Treatments	0.176	0.042
S.E. of difference between two Treatments	0.203	0.048

TABLE V—MEAN pH VALUES

DATES OF SAMPLING FOR pH	None	FERTILIZER			
		Nitrate 18 lb. N.	of Soda 36 lb. N.	Sulphate of 18 lb. N.	Ammonia 36 lb. N.
19th May	5.80	5.76	5.72	5.87	5.67
30th June	5.82	6.22	6.26	5.27	4.94
28th November	5.57	6.09	6.18	5.06	4.40

An account of this work is to appear in the *East African Agricultural Journal*.

Lucerne

A study of Lucerne, cut on each occasion it reaches the early flowering stage of growth, was begun in May, samples being obtained from a $\frac{1}{4}$ -acre plot of Lucerne established in August, 1952, on Mr. J. F. Lipscomb's farm, South Kinangop. This plot, which is sited on an 8° slope, can be irrigated when desired, from a nearby concrete water tank. Soil variation within the plot may be judged on the analyses of topsoil taken from three different sites.

TABLE VI—SOIL ANALYSIS (ON AIR-DRY BASIS)

	Site 1	Site 2	Site 3
pH	5.2	6.5	5.1
N per cent	0.34	0.76	1.01
Organic C per cent	3.38	7.39	10.70
Ratio C : N	9.94	9.72	10.59
CaO M.E. per 100 g. soil	6.88	24.52	18.96
K ₂ O M.E. per 100 g. soil	0.46	9.19	3.83
Total Exchangeable Bases M.E. ..	8.87	36.72	22.42

Site 1 is at the foot of the slope, Site 2 at the top, and Site 3 approximately midway. The soil on Site 3 is very rich in nitrogen and this is probably due to the fact that this site is on an old drainage course from the byres and dairy, and material of organic origin accumulated periodically on it.

From May onwards, samples of Lucerne were obtained on each occasion the crop reached the early flowering stage of growth. The samples were air dried, after which leaf and stem were separated from a known weight of material, weighed separately, and ground for analysis. Results of analyses are given below; they are calculated on a dry-matter basis:—

	25TH MAY		29TH JUNE		31ST JULY		8TH SEPTEMBER		21ST OCTOBER		11TH DECEMBER	
	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem
Ash	9.90	16.03	10.46	12.28	10.36	15.57	10.61	6.77	9.94	9.41	9.86	7.92
Crude protein ..	31.22	25.84	34.05	17.49	33.79	23.02	37.30	22.73	33.24	24.35	33.51	17.22
Ether-extractives ..	3.47	1.42	3.91	1.84	3.33	1.03	3.33	1.37	2.98	3.26	4.98	2.76
Crude fibre ..	11.50	25.61	12.97	25.19	13.62	31.75	11.66	32.96	15.10	32.04	12.30	37.18
Carbohydrate ..	43.91	31.10	38.61	43.20	38.90	28.63	37.10	36.17	38.74	30.94	39.35	34.92
True protein ..	26.64	13.80	30.48	15.16	21.12	7.40	26.30	10.69	21.18	9.94	24.11	9.75
Per cent digestibility of crude protein ..	87.5	88.5	86.7	83.4	88.8	89.1	90.0	89.1	85.7	87.8	85.4	85.2
Lime CaO ..	1.25	0.81	1.32	0.81	1.21	0.63	1.41	0.75	2.04	1.34	1.76	0.95
Phosphoric oxide P ₂ O ₅ ..	0.81	0.87	1.02	1.07	0.89	0.89	0.99	0.90	0.67	0.73	0.76	0.61
Ratio CaO : P ₂ O ₅ ..	1.54	0.93	1.29	0.76	1.36	0.71	1.42	0.83	3.40	1.83	2.31	1.55
Ratio Leaf : Stem ..	1.21	1	1.28	1	1.22	1	1.06	1	1.16	1	1.12	1

These data show that on all occasions the proportion of leaf is higher than that of the stem, and that the leaf is richer in its percentage content of crude protein and of minerals and it is much less fibrous. The percentage digestibility of the crude protein in both leaf and stem, as determined by the "in vitro" pepsin digestion method of Wedemeyer, is high. The differences obtained both for leaf and stem, between values obtained for crude protein and for true protein show that much of the nitrogen present in the Lucerne is non-protein nitrogen.

For the minerals, lime is consistently higher in the leaf than in the stem, but phosphoric oxide values in stem and leaf are similar. The ratios of lime to phosphoric oxide show considerable variation and in no instance approach the value advocated by Woodman of $1.13 \text{ CaO} : 1 \text{ P}_2\text{O}_5$ (*Bull. 48 of Min. of Agriculture, H.M.S.O., 1948*).

This study is still in progress.

Other Work

Under this heading is included chemical evaluation of herbage obtained from experiments conducted on our Grassland Stations at Molo and Kitale. Such experiments included, at Kitale, ley establishment trials, the utilization and management of Elephant grass and the use of Napier grass for dry season feed: at Molo, ley establishment trials with different types of Cocksfoot and Rye grass, and an experiment on Lucerne. Many samples of hays, grasses and legumes obtained from individual farms were also analysed, together with samples of artificially dried grass and lucerne obtained from the farm of Dr. R. V. Bowles at Subukia.

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List of Publications

- (1) H. W. Dougall, "Fertilizer Experiments on Ley Establishment, Established Leys, and Natural Pastures in the Kenya Highlands". *E.A. Agricultural Journal*, July, 1953.
- (2) H. W. Dougall, "Kikuyu Grass I: Seasonal Variation in Composition of Degenerate and Productive Pasture Herbage". *E.A. Agricultural Journal*, December, 1953.
- (3) A. V. Bogdan, "Observations on Stoloniferous Grasses in Kenya". *Journal of the East African Natural History Society*, vol. XX, No. 2, December, 1952, Nairobi.
- (4) W. R. Birch, "Some Problems of Pasture Improvement". *Kenya Weekly News*, 1953.
- (5) W. R. Birch, "Spurrey Control". *Kenya Weekly News*, 1953.

E. D. BUMPUS,
Senior Pasture Research Officer.

ANNUAL REPORT, HORTICULTURE, 1953

Meteorological figures for 1953

MOLO

MONTHS	Rainfall Inches	Hours Sunshine	Mean Temperature
January ..	0.34	275.7	57.6°F.
February ..	0.08	262.9	57.9°F.
March	1.34	271.4	59.1°F.
April	3.90	237.2	59.5°F.
May	4.07	253.6	57.2°F.
June	5.63	183.8	56.6°F.
July	3.05	238.0	54.5°F.
August	5.58	166.3	54.9°F.
September ..	1.90	211.5	55.7°F.
October	3.03	230.7	57.1°F.
November ..	2.86	172.3	56.9°F.
December ..	4.08	237.4	57.5°F.
Total ..	35.86	2,740.8	57.0°F.

MATUGA

Rainfall

Rainfall during the year 1953 totalled 53.47 in. and fell as follows:—

January	3.60 in. over 8 days.
February	.37 in. over 2 days.
March	1.15 in. over 7 days.
April	6.25 in. over 15 days.
May	11.00 in. over 16 days.
June	.38 in. over 3 days.
July	5.26 in. over 15 days.
August	4.07 in. over 15 days.
September ..	3.47 in. over 13 days.
October	11.89 in. over 13 days.
November ..	6.03 in. over 6 days.
December ..	NIL.

JACARANDA

MONTHS	Rainfall Inches	Maximum Temperature	Minimum Temperature
January ..	0.52	85.8	46.2
February ..	Nil	86.5	46.0
March	2.36	85.0	52.5
April	5.03	85.8	55.8
May	5.55	79.6	53.0
June	1.12	82.6	48.5
July	0.68	84.7	43.0
August	1.51	78.3	44.2
September ..	0.94	84.5	46.8
October ..	4.07	83.5	51.1
November ..	4.62	83.5	52.5
December ..	1.59	81.9	47.4

Deciduous Tree Fruits

Unseasonable frosts at Molo during July-August caused deciduous fruit trees to break their dormancy better than usual, though mean temperatures were not lower than normal. As a result all fruits set good crops, in fact the crop on most plum varieties was too heavy, with consequent deterioration in quality.

Apples

Blenheim Orange

The outstanding variety for yield of fruit in the 1953-54 and previous seasons is Blenheim Orange. The cropping record for trees of this variety on Cape Seedling rootstock, planted in 1947, is as follows:—

TREE NUMBER				SEASON			
				50/51 <i>lb.</i>	51/52 <i>lb.</i>	52/53 <i>lb.</i>	53/54 <i>lb.</i>
329	..	..	..	8	22	21	50
330	..	..	..	15	40	44	60
331	..	..	..	18	17	45	94

The variety is susceptible to Bitter Pit, but the fruit was less affected this season. It is likely that Bitter Pit will decrease progressively as the trees become older, provided excessive amounts of nitrogen are not applied.

Reinette du Canada

This variety cropped for the first time this season. The fruit is of high quality and attractive appearance. The tree is a vigorous grower on Crab rootstock, and it is expected that it will prove to be a commercial variety in Kenya.

Gravenstein

The crops borne so far by Gravenstein are rather disappointing when compared with Blenheim Orange, but it is possible that crops will improve when the trees are older. As a dessert apple Gravenstein is of disappointing quality, but this season the half ripe fruit sold well as cooking apples. By selling the fruit at this stage of ripeness losses through Bitter Pit can be avoided.

Sharp's Early

This variety is strongly recommended for planting as an early variety. The fruit is of very attractive appearance, crisp, and of good flavour, but it will not keep. Sharp's Early is a weak-growing variety and requires to be worked on a vigorous rootstock if trees of reasonable size are required. Seedling Crab appears to be a satisfactory stock at Molo but trees on Cape Seedling roots are very dwarfed although they bear good crops. Trees on this stock would probably be suitable for growing on an intensive system at a spacing of 8 to 10 feet.

Rootstocks

For the reasons given in the Annual Report for 1952, it was decided not to plant a statistical rootstock trial at this stage. An observational apple rootstock

trial was therefore planted in July. The stock scion combinations used were as follows:—

BLOCK B, IRRIGATED

					<i>Trees</i>
Blenheim Orange on MM108	..	..	..	..	22
Jonathan on MM108	..	..	..	..	7
Gravenstein on MM108	..	..	..	..	16
Gravenstein on MM107	..	..	..	..	31
Jonathan on Crab "C"	..	..	..	..	7

BLOCK C, UNIRRIGATED

					<i>Trees</i>
Blenheim Orange on MM108	..	..	..	..	26
Jonathan on MM108	..	..	..	..	8
Gravenstein on MM108	..	..	..	..	17
Gravenstein on MM107	..	..	..	..	40
Jonathan on Crab "C"	..	..	..	..	8

In this trial Jonathan is the pollinating variety; as it is also a weak grower it is being tried on the Crab "C" rootstock which would probably be too vigorous for the other two varieties. The trial is planted on bench terraces at an approximate spacing of 20 by 20 ft. One terrace is planted at a spacing in the row of 12½ ft.

New Plantings

The following varieties were planted out for trial in Block D, all on Crab rootstock: Early Lemington, Yellow Newtown Pippin, Golden Delicious, Rhode Island Greening, Boiken, Laxton's Exquisite, and Lord Lambourne.

Pears

Packham's Triumph

Trees of Packham's Triumph received from Stellenbosch on B15 and B4 rootstocks were planted out in 1947. This season, trees on B15 bore their first crop. Most of the nearly mature fruits suffered from what appears to be "Black End". Affected fruits develop small black spots about the blossom end which later coalesce until the whole end of the pear is black and dry. Black End is caused chiefly by working pears on roots of the Japanese (*Pyrus scrotina*) species or its hybrids. Confirmation that B15 is a Japanese root has still to be received from Stellenbosch. Trees on B4 rootstock have not yet started bearing, they are considerably less vigorous than trees on B15.

Keiffer

Keiffer pears planted in 1947 are now coming into bearing. One drawback of this variety is its extremely upright and tall habit of growth. This makes spraying, pruning and particularly harvesting, difficult. If the leaders are bent over to an angle slightly above the horizontal when they have attained a length of about 6 ft. the trees can be trained to a much more manageable shape. Trees trained in this way usually come into bearing a season or two earlier than those left to grow upright.

New Plantings

The following pear varieties on pear rootstocks were planted out in Block B, under irrigation. A duplicate planting was made in Block C, unirrigated: Clapp's Favourite, Winter Safraan, Fertility, December, Sweet Safraan, Louis Bonne, and Forelle.

Plums

Beckie Smith

October Purple has always been considered the best late variety of plum in Kenya but it appears that Beckie Smith may be superior in some respects. The fruit is large, round and purple skinned with yellow flesh. Harvested at the same time or a little later than October Purple, Beckie Smith has the great advantage of keeping well in store. In the 1953-54 season, Beckie Smith plums were still in good condition at the end of March, after four weeks' storage in the fruit cellar at Molo. Trees planted at Molo in 1947 are small, probably because they are infected with Crown Gall, but they have a good spreading habit of growth. The mean crop per tree from three trees this season, was 43 lb.

Methley Type

The Methley type plums include the varieties Methley, Tazagine and Settler, which are indistinguishable one from the other. This type of plum, except in the occasional off-year, overbears consistently. Although this appears to have little adverse effect on the trees themselves, it results in a large proportion of the crop being of very small-sized fruit. Large quantities of poor quality Methley plums tend to glut the market and depress the price for better quality fruit. It is important therefore to improve the quality of Methley type and the only effective means of doing this is by thinning the crop soon after it has set. Hand thinning would not be economic but it is possible that chemical thinning by means of a spray would be successful. Trials in chemical thinning are to be carried out at Molo during the coming season. Methley type trees on their own roots continue to bear better crops and to be more regular in growth than those on rootstocks.

Peaches

Seedling peaches, produced from seed of seedling trees in Mr. J. F. Rousseau's orchard at Lessos, bore their first crop at Molo this year. The trees can be separated into two types by fruit characters—

(a) yellow fleshed freestone with yellow skin; and

(b) yellow fleshed freestone having a red blush round the pit. Skin yellow with bright red cheek.

Both bear fruit of large size with firm flesh; they should be classified as stewing peaches but if the fruit is allowed to become soft it can be used for dessert purposes. It is possible to use the fruit for canning but the quality is not as good as for yellow fleshed clingstones. Type (b) is of very attractive appearance and should therefore be a better market variety than (a). Both types are recommended for planting in peach growing areas.

New Introductions

A number of trees have been successfully propagated from budwood of three new peach varieties imported from America. These three varieties have been bred for planting in Southern California where the temperature conditions are similar to many parts of Kenya. These varieties have propagated at Molo

and at Border River Nurseries on Mount Elgon. The trees are making good growth but are not yet old enough to bear fruit. It seems likely that they will be successful in Kenya in peach growing districts. The varieties, together with a brief description, are as follows:—

Bonita.—Fruit medium to large, skin light yellow with deep red blush. Freestone; flesh yellow with pink round the stone. Quality good.

Ventura.—Fruit slightly flattened, attractive in appearance but rather small in size. Skin yellow with red blush. Freestone; flesh yellow. Quality fairly good.

Selection 338-7.—A yellow freestone.

Bird Damage to Fruit

Bird damage has been much worse during the 1953-54 season than previously, probably owing to the exceptional drought. Even in normal seasons the damage to late varieties of fruit is always considerable. Where varieties are planted in large blocks away from forests, birds can be controlled by means of bird scarers and shooting. It is in the home orchard and where only a few trees of each variety are grown, particularly if the orchard is sited close to forest, that the damage becomes really alarming. Under these conditions birds usually destroy the whole crop of late varieties, and unless some means is found of combating them, it is not worth while to plant any variety which ripens later than January.

In order to obtain an accurate record of the crop of some of the later varieties at Molo this season, some individual tree cages were constructed. These cages are portable and by moving them on to later varieties as the season advances, it is possible to protect four trees in a season with each cage. An example of the difference in crop between caged and uncaged trees is given below:—

Plum, Beckie Smith—

caged	..	..	..	..	50 lb.
uncaged	..	..	..	..	nil

The cages were designed purely for experimental purposes but it appears from the results that they would, in some cases, be an economic proposition. The cost of a 10 ft. cube cage with 3 in. by 2 in. cedar frame, covered with $\frac{1}{2}$ in. wire netting, excluding labour, was Sh. 160. The estimated life of a cage is five years. Used on four trees in a season the cost of the cage could be repaid by the gross value of the fruit saved in one season.

Nursery Work at Molo

We have not yet worked out a consistently satisfactory method of raising fruit trees under our rather difficult conditions. Part of the difficulty is caused by the poor soil and unfavourable aspect of the nursery. The main trouble, however, is that we have not yet got a stock sufficiently resistant to prolonged dormancy. The stocks we have at present are difficult to get in to a suitable condition for working. Once transplanted from the stool they tend to remain dormant for at least a season. While a dormant stock may be grafted, it would be useless to graft it before it has developed a sound root system. This may take two years or more. In the absence of better stocks the difficulty might be largely overcome by cultural modifications—by mulching layer beds to improve rooting, by converting stools to layer beds to attempt to get less vigorous but better ripened stocks and possibly by the early removal of layers and storing them for some weeks in a cool cellar prior to lining out.

The actual method to be used in working the stocks would be simple if they could be brought into a better condition and normal shield budding would then be the simplest to carry out. Chip budding does not always give good results. It works well when the stocks are active or are coming into an active condition, but not when they are poorly rooted or dormant. Whip and tongue grafting has given better results than chip budding on dormant stocks this year and it is likely that grafting, using chilled wood, could be relied on to give a more reliable take. This is probably because the cutting down of a dormant stock usually stimulates it into growth thus resulting in quicker joining of the stock and scion.

Bench grafting may prove a useful aid in propagation. Almost all those put on have taken though growth is variable due to the insufficiently chilled wood used—this consisted of the odd pieces of dormant wood to be found on the trees in November.

A preliminary shading experiment was tried on the stunted trees on terrace 16. The trees have got into a poor condition and have made little growth for several years. This may not be due to lack of chilling or poor soil. High light intensities tend to encourage fruit bud formation at the expense of growth. The shading was put on to cut down light and temperature during early March in the hope of stimulating vegetative growth either at the time of application or in the subsequent season. It was left on during the dormant season to ensure adequate chilling. Growth was considerably better this year and it seems that this might be further investigated.

Some marcotting of apples was done, using Alkathene wrapping, but in no case were roots formed after five months. Callusing was extensive but the marcots failed to root after removal from the parent.

A trial of propagation of Crab C by root cuttings resulted in a reasonable take, but the method seems unduly slow and uneven and it does not appear that it would be a practicable means of raising this rootstock.

Some plants of the apple varieties Blenheim, Gravenstein and Jonathan have been obtained on their own roots, though rooting was not good.

Chilled budwood was this year used in propagating some varieties of apple. Unfortunately much of the wood was killed by moulds and results are rather confused. However, it was noticed that unchilled wood frequently produced dwarfed and stunted shoots. It appears that chilled wood may be of definite use in promoting more vigorous and even growth of scions, particularly if grafting has to be done.

The general condition of the stool beds is poor and almost all should be replaced. Also the Myrobalan B stocks appear too vigorous, producing too many thick stocks which transplant poorly. It would probably be better to grow this stock from cuttings. Some varieties of plum have rooted poorly from cuttings and it might be well to lay down layer or stool beds to raise these varieties. Alternatively some easily rooted Japanese variety might be used as a stock. Part of the dwarfing caused by grafting may be caused by partial incompatibility between European stocks and the Japanese scion varieties.

The take of buds this year has been unsatisfactory partly due to much of the budwood being dead and partly to the fact that chip budding is not satisfactory when used on dormant stocks.

Trial of Two Substitutes for Grafting Wax

Two propriety products known as "Flintkote" and "Microwax" were tested at Molo as sealing compounds for grafts on apple stocks. "Flintkote" is a black bituminous fluid of the consistency of thin paint. It is applied cold and after exposure to air for an hour or so hardens into a resilient weatherproof compound which remains effective for several months. It appears to have no phytocidal properties and proved perfectly satisfactory in sealing both whip and tongue and chip grafts. It is easier to use than normal waxes as it does not require heating. Also it costs only a fraction of the price of grafting wax. With budding, results were as good as those obtained with sealing grafts. It should not be used in rain or when the temperature is below 45°F.

"Microwax" is a semi-transparent pale yellow compound rather resembling paraffin wax. It requires melting over a fire before use and has a tendency to run off the brush if overheated or to solidify before it can be applied to the graft. Also, being almost colourless, it is difficult to see if all surfaces and cracks have been safely sealed. It proved less satisfactory than either "Flintkote" or ordinary grafting wax and is not recommended for use in cool climates.

Sub-Tropical Tree Fruits

Citrus at Matuga

Many of the young citrus trees in the variety orchard at Matuga bore their first crop this year. In many cases, quality of the fruit was disappointing, the incidence of granulated fruit being high. Granulation is likely to be a fairly serious problem in citrus at the Coast owing to the hot, humid climate. Granulation is a very complex physiological problem. Apart from climatic causes over which we have little or no control, the main factors affecting its incidence are, varieties, rootstocks, and possibly the use of seedling instead of budded trees. Lack of irrigation is likely to be a contributory factor. Investigational work now being carried out, will eventually reduce losses caused by granulation very considerably, but it is very unlikely that it will ever be completely eliminated. Too much importance should not be attached to the incidence of granulation on young trees. The true susceptibility of a tree can only be assessed when it has reached maturity.

Fruit harvested from the Meyer Lemon at Matuga was of exceptional quality. The juice content was very high. This variety is being recommended for local planting. Mexican lime has also done well during the year, bearing heavy crops.

A number of seedling selections have now been made from mature orange trees in the Junju area, which appears to be one of the best citrus seedling areas of the Coastal strip. The selections are for the purpose of seed parents for raising good quality seedling trees for distribution in African areas.

Citrus Rootstock Trials

The delay in commencing this trial has been in raising of stocks, *Poncirus trifoliata* being extremely slow. By the end of the year many hundreds of healthy *Poncirus* seedlings were ready for transplanting from seedbeds, sown April, 1952, while older seedlings planted out at the end of 1952 are large enough to commence budding. Other rootstocks in the trial, rough lemon and sweet orange, are grown from seed taken from a locally selected tree in each case. The sweet orange selection was made during the year, while rough lemon was previously selected at Taveta.

Granulation of Citrus Fruit

Investigation was started towards the end of the year on the physiological disorder of granulation of citrus fruits, which has been bad on budded orange varieties, particularly Velencia Late. A great deal of further work needs to be done on this before a satisfactory explanation of cause, and so control, can be given. Granulation is, at present, much worse among budded varieties than seedling citrus. But it is to be remembered that all budded trees to which we have access for investigation are young, bearing only first to fourth crops, and that in older trees this granulation might not be so severe.

Sub-Tropical Fruit at Jacaranda

Table I shows the annual growth rate of fruit trees planted with and without irrigation during 1951. One year was allowed for establishment following planting, at the end of which time a base measurement was taken. The measurements shown are founded on the first base measurement and represent the mean growth rate of the six trees of any one kind and their varieties between June, 1952 to May, 1953. Girth measurements were taken one foot above soil level.

TABLE I—IRRIGATED AND UNIRRIGATED TREES

KIND	VARIETY	DATE PLANTED	IRRIGATED		UNIRRIGATED	
			Girth Growth 1952-1953	Total Girth	Girth Growth	Total Girth
			<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>
Tangerine ..	Cape Naartje ..	21-4-51	1.44	3	1.43	2.90
	Satsuma	"	1.75	4	1.81	4.31
Orange ..	Temple	"	2.05	4.5	1.70	4.50
	Sabina	"	1.70	4.7	1.56	4.56
	Hamlin	"	0.84	4.7	1.44	4.44
	Washington Navel	17-7-51	2.50	3.8	1.70	4.37
	Valencia Late ..	"	1.20	4.2	2.10	4.80
	Renmark Navel ..	"	2.12	4.79	1.60	4.30
Lemon ..	Lue Gim Gong ..	"	3.00	4.25	1.58	4.58
	Eureka	"	3.00	6.00	2.45	5.29
	Ville Franca ..	"	3.25	5.58	2.37	5.37
	Meyer	"	2.37	5.40	1.25	3.25
	Marsh's Seedless	"	2.30	5.00	1.29	4.29
Grape Fruit ..	Triumph	"	1.80	4.80	1.20	4.20
	Adam	21-4-51	0.12	3.80	0.25	4.00
	White Genoa ..	"	1.12	5.12	1.12	6.12
Fig	Green Ischia ..	"	1.40	4.50	1.62	4.62
	Fuerte	"	3.00	8.50	2.12	6.62
Avocado Pear						

The mean difference of growth between irrigated and unirrigated trees over a one-year period following establishment is as follows:—

<i>Citrus species—</i>				<i>Girth</i>	<i>Height</i>
Irrigated	..	..	..	2.09"	1' 8"
Unirrigated	..	..	..	1.67"	1' 5"
<i>Fig—</i>					
Irrigated	..	..	..	0.88"	0.8"
Unirrigated	..	..	..	0.99"	1' 3"
<i>Avocado Pear—</i>					
Irrigated	..	..	..	3.00"	1' 2"
Unirrigated	..	..	..	2.12"	1' 2"

Irrigation has had an influence on the citrus and figs which show a slightly quicker growth rate on the former and what might be an inhibiting effect on the latter. There does not appear to be any significant response on the avocado pears. Any marked responses to irrigation, however, are not expected until the trees are more fully established, especially when the bearing stage is reached.

Any tendency to fruiting among the citrus has so far been discouraged by removal of the fruit. When trees either attain reasonable dimensions or have been planted in the field for three years fruiting will be permitted. The response of unirrigated citrus trees to the rains, or even rains of one inch, is almost immediate. The trees recover from the flagging state and come into full blossom regardless of season, while the irrigated trees show no sign of flowering. Since the May, 1953, measurements were made there has been a marked difference between the growth rate of the irrigated and non-irrigated lemons. The irrigated lemons are almost half as high again as the unirrigated trees but the growth is very much weaker and less dense than on the unirrigated trees, which may be described as first class.

The irrigation frequency has been the same for all the tree fruits under cultivation and has worked out at once a month during dry periods. A four-inch mulch is maintained under all the trees. The rainfall equivalent for irrigation was six inches and the number of irrigations during the year was five.

Major pests consisted of aphids, leaf eaters and scale. Control measures were effected by D.D.T. Wettable Powder for the former and alboleum was used successfully against scale.

Of the several species of fruit trees planted only Mountain Pawpaw, as will be seen later, has as yet been the only real failure under the climatic conditions of Ruiru. Mexican Hawthorn and Cashew Nut, though making good growth and flowering well, show few signs of fruit production. Youngberry plants also show little promise though these may require more time to get well established.

Mountain Pawpaw

This fruit has not compared favourably with that grown at the higher altitudes either for fruit size or yield. The yield over the two and a half years since planting totalled 2,986 lb. per acre at an 8 ft. by 8 ft. spacing. The mean fruit weight over the same period was 1.9 ounces. As sufficient information has now been accumulated regarding yield at 5,400 ft. the trial has been discontinued.

Banana

No yield results are yet available relating to the irrigated versus unirrigated trial which was commenced during September, 1952, except that the irrigated plants were slightly taller and more vigorous than the unirrigated plants. Of the coastal varieties planted during August, 1951, the first yield results are as shown in Table III.

TABLE III

Variety	Harvesting Commenced	Harvesting Completed	Yield Per Acre-Tons	Mean Weight Per Bunch	
				lb.	oz.
Kitarrasa	21-10-52	9-1-53	10.1	33	07
Imange	10-2-52	9-1-53	10.8	35	14
Kashmiri	10-6-52	9-2-53	4.0	13	06
Kisukari, No. 2 ..	24-1-53	9-2-53	5.7	19	02
Kisukari Kipukusa, No. 1	3-10-52	23-2-53	4.7	15	09
Trurue, No. 1	29-2-52	1-7-53	8.3	27	06
Kimilindi Kingurue ..	15-10-52	9-2-53	8.6	28	10
Bokoboko Mkojoze ..	29-5-52	18-5-53	4.2	14	02

The above are of good quality with Trurue No. 1 being the best flavoured of all. The remaining varieties are completely useless with regard to flavour and have been abandoned.

Other Sub-Tropical Fruits at Matuga

Mangoes.—No end of the year crop was harvested, it having been lost through exceptionally heavy October rains just after blossoming time. This is the crop taken by us for propagation work, consequently mango seedlings for sale in 1954 are limited to a few left over from the 1953 planting season. Growers are becoming more interested in these better types.

Litchi propagation.—Marcottage on Litchis at Malindi met with success during the year. Work continued on this propagation.

Bananas.—Gros Michel is proving successful at Matuga. It needs to be seen now whether this variety is susceptible to the strain of Panama disease prevalent along the Coast.

Sub-Tropical Fruits at Kitale

Trees at Kitale are now well established. A few lemons have already been harvested. Avocados are starting to come into bearing.

Lemons at Molo

Very good results were obtained by curing lemons at Molo. The cured fruit had a very deep even yellow colour and the skins were relatively thin. The fruit sold on the local market at Sh. 7 to Sh. 9 per 100. Fruit for curing is placed loose in boxes and kept in the fruit cellar for about six weeks. The cellar has a temperature of 50–55°F. and a humidity in the region of 100 per cent.

Pineapples

Central Province

Expansion of the pineapple industry in the Province has been quite considerable since 1950. Though the exact acreage is not known, the figures available indicate that for each productive acre in 1950 an additional 23 acres had come into production by the end of 1953. As coffee and sisal planters appreciate the necessity for diversification, more and more pineapples are being planted and consequently the expansion rate is expected to be maintained.

As there was no land available at the Fruit Station, a one-and-a-half acre block of pineapples has been planted at the Coffee Research Station farm to enable a study of pineapples grown as a rotation crop. Outside the station, a number of co-operative pineapple trials have been commenced at Karimaini Estate, Thika, and also at Sisal, Ltd., Makuyu.

Co-operative Experiments

The following trials were in progress during 1953 at Karimaini Estate, Thika:—

- (1) 2⁴ factorial trial on effects of nitrogen, iron, magnesium and soil fumigation.
- (2) 2⁴ factorial trial on effects of nitrogen, phosphate, potash and mulching.
- (3) Randomized block trial comparing three spacings with and without mulch.

(4) Observational trial on the effect of copper, manganese and pre-planting soil fumigant.

(5) Trial with "Planofix" for the acceleration of fruiting.

The first trial, which was begun in December, 1951, has produced a plant crop and, although the experiment will be continued into the Ratoon crop, the results from the plant crop are interesting. The main object of the trial was to find out if it would be economically possible to follow one cycle of pineapples with another on the same land as hitherto, results have been unsatisfactory in these circumstances. The trial was planted with fruit crowns in three-row beds, with 9 ft. between the beds and 1 ft. x 2 ft. between plants in the beds. The treatments were: (a) nitrogen as 2,000 lb. sulphate of ammonia per acre versus nil; (b) magnesium versus nil; (c) iron versus nil; and (d) post-planting soil fumigation with ethylene dibromide versus nil.

The first applications were made during December, 1951. Sulphate of ammonia was applied at the rate of 500 lb. per acre to the base leaves at bi-monthly intervals over a period of eight months. The final application being made in March, 1952. Magnesium was applied in the form of a spray at 2 per cent at monthly periods over five months. Sulphate of iron was similarly applied but in this case there were six applications. Ethylene dibromide was applied during May, 1952, as a single application in a 10 per cent concentration. Application was by means of hand injector pump. The first harvests were made during February, 1953; the final harvests being made during October of the same year. The main results are summarized in Tables II, III, IV and V.

TABLE II—EFFECT OF NITROGEN (N) AND FUMIGATION (D) ON YIELD

					O	N	Mean
O	..	Tons per acre	..	..	9.5	12.5	11.0
		No. fruit per acre	..	..	6,241	6,908	6,574
D	..	Tons per acre	..	..	6.6	11.5	9.0
		No. fruit per acre	..	..	4,324	6,466	5,394
Mean	..	Tons per acre	..	..	8.1	12.0	10.0
		No. fruit per acre	..	..	5,282	6,687	5,984

TABLE III—EFFECT OF IRON (Fe) AND FUMIGATION (D) ON YIELD

					O	Fe	Mean
O	..	Tons per acre	..	..	11.6	10.4	11.0
		No. fruit per acre	..	..	6,949	6,199	6,574
D	..	Tons per acre	..	..	8.2	9.8	9.0
		No. fruit per acre	..	..	5,008	5,782	5,395
Mean	..	Tons per acre	..	..	9.9	10.1	10.0
		No. fruit per acre	..	..	5,976	5,991	5,984

TABLE IV—EFFECT OF NITROGEN (N) AND IRON (Fe) ON FRUIT WEIGHT
MEAN WEIGHT OF FRUIT, LB.

	O	N	Mean
O	3.34	3.91	3.62
Fe	3.27	4.22	3.75
Mean ..	3.30	4.06	3.68

TABLE V—SUMMARY OF SIGNIFICANT MAIN EFFECTS AND INTERACTIONS

Main Effect or Interaction	Tons p.a.	No. fruit p.a.	Average Weight of fruit, lb.
N	+3.9	+1,405	+0.76
D	-2.0	-1,180	
FeD	+1.4	+762	
N.D	—	+738	
Significance level, $p=0.05$	1.2	700	0.20
Significance level, $p=0.01$	1.6	919	0.26

Although it has been proved that nitrogen is capable of increasing the plant crop yield of pineapples on soils that have produced a complete cycle previously, the increase in yield, at 3.9 tons per acre, is not so great as was expected from an application of 2,000 lb. of sulphate of ammonia per acre. The total cost of the sulphate of ammonia at Sh. 712 per ton was Sh. 635/60 per acre. To this amount must be added the cost of transporting the nitrogen from the source of supply to the estate, together with the cost of application. The present day value of pineapples for canning is Sh. 200 per ton ungraded and the increase in the plant crop value brought about by using sulphate of ammonia was Sh. 780 per acre, resulting in a basic difference between cost of fertilizer and crop return of Sh. 45. It is most important, however, when considering the economic factor that the long-term effect of the sulphate of ammonia be taken into account. As the relative increase in the ratoon crop yield is expected to be maintained as a result of the treatment and since the cost of the sulphate of ammonia will have been covered by the plant crop, the yield increase from the ratoon crop should therefore result in net profit.

Another important aspect arising from the sulphate of ammonia treatment is that if pineapples were graded and paid for on a fruit weight basis, a greater margin of profit would result. Nitrogen has increased the average fruit weight significantly, by 0.76 lb. The percentage of fruits of 4 lb. and over with nitrogen was 50.3 per cent, whereas without nitrogen it was 17.4 per cent, a highly significant difference. It is claimed that fruits of 4 lb. and over are ideal for canning and consequently the value of a crop with a high percentage of fruits of this weight and over should be of greater value than crops with a very low percentage of 4-lb. fruits. Moreover, it may be possible that lighter applications of sulphate of ammonia may prove as effective as the 2000 lb. per acre application.

With regard to yield results generally, yields per acre on the new spacing which enables the planting of 17,000 plants per acre instead of 10,000 will be much higher than those produced in the trial.

The main effect of fumigation with Ethylene dibromide was a significant reduction in yield of 2.0 tons per acre. This decrease in yield due to fumigation was less in presence of iron, as shown by the significant positive interaction, and nitrogen also probably had a mitigating effect as on fruit number and interaction is significant, although with yield it is not. There would probably have been no adverse effect from fumigation had it been done before planting. Fumigation was carried out during May, 1952, almost a year after planting. By November, the plots treated with ethylene dibromide only were showing signs of chlorosis. Some chlorosis was also observed in plots treated with magnesium and iron but not in plots treated with nitrogen. The effect of the dibromide would seem to have been partially to destroy the young root tips of the less vigorous non-nitrogen treated plants causing a consequent growth check with root recovery being too late to enable normal fruiting to take place.

Early visual response to any of the treatments used in the trial was negligible except in the case of nitrogen. Following the first application, which was made during December, 1951, and when the plants were well supplied with moisture, there was a slight colour improvement by the end of the first month, from yellowy-bronze to a distinct healthy bronze-green, which increased with each application until the 1,500-lb. mark had been reached. Following the next 500 lb. per acre application, which was made during March, 1952, a scorched appearance developed on the leaves with some damage to leaf tissues. As no further applications were made, the trouble did not develop and traces of scorch later disappeared. It is believed that the scorch may have been caused by making applications of nitrogen while the moisture condition of the plant was too low for conversion; the time of application representing the end of the long dry season.

It appears probable that the combination of iron and nitrogen had the effect of increasing the percentage of fruits weighing 4 lb. and over and also of increasing the proportion of fruit harvested in the early part of the year, from March to May. (See Table VI.)

TABLE VI—EFFECT OF NITROGEN (N) AND IRON (Fe) ON FRUIT SIZE AND HARVESTING TIME

		O	N	Mean
O	Per cent fruit 4 lb. or over	17.3	46.9	32.1
	Per cent fruit harvested March-May	18.6	25.0	21.8
Fe	Per cent fruit 4 lb. or over	17.4	53.2	35.3
	Per cent fruit harvested March-May	21.3	30.9	26.0
Mean ..	Per cent fruit 4 lb. or over	17.4	50.3	
	Per cent fruit harvested March-May	20.0	27.9	

Quite a lot of leaf tip die-back was recorded during the fruiting period on a number of plots. The plot analyses show that the degree of die-back was greater on plots which were bearing heavy fruit. As leaf tip die-back was associated with fruiting, it may well be that on reaching a certain size and if climatic conditions be unfavourable, the fruit may be capable of completely withdrawing nitrogen from the leaf tips where it is more concentrated, ultimately causing a collapse of the tips to a greater or lesser degree depending upon the amount of nitrogen withdrawn.

The number of plants producing fruit is important and the results would seem to indicate that greater consideration is required in the selection of planting material. Of the untreated plants only 66.7 per cent of the total produced fruit and of the nitrogen treated plants 74.9 per cent produced fruits.

Of the trials still in progress at Karimaini Estate, there is little to report in the fertilizer trial except that no difference can yet be detected in plant vigour between the plants planted in the interbed space of the previous cycle and those planted in the original bed. The nitrogen treated plots show colour improvement and slightly more vigour than the no nitrogen plots while the mulch only plots show almost equal colour and vigour as the nitrogen plots.

In the spacing trial the colour and vigour is markedly better on the mulched plots than on the unmulched.

The trace element trial using manganese and copper shows improvement in colour and vigour on the manganese treatments. The copper treatment may prove to be unfavourable.

A fertilizer trial was commenced at Sisal Ltd., Makuyu, during May, 1952, in an attempt to stimulate pineapples which had been planted a year earlier and which had made little or no progress since planting. The soil on which planting had taken place was in very poor condition having previously been cropped with maize. Considerable erosion had also taken place. Nitrate of soda was applied both in granulated form and in solution. Granules were applied at the rate of 500 lb. and 2,000 lb. per acre at the rate of 500 lb. per application while the solution was sprayed in concentrations of 4, 5, 8 and 10 per cent. As there was no response whatever to the nitrate of soda either in granulated form or in solution it was decided to use sulphate of ammonia. Magnesium sulphate and iron sulphate had also been sprayed at 2 and 4 per cent concentrations but without any response.

The sulphate of ammonia applications were first applied during December, 1952, at the rate of 500 lb. per application, reaching a maximum of 6,000 lb. by November, 1953. The first response to sulphate of ammonia was observed five months after the first application and when the rate of application had reached 2,500 lb. per acre. On reaching the 6,000-lb. per acre dressing, there was a marked colour improvement and very slight progress in plant development. Because of unsatisfactory response and because sulphate of ammonia at 6,000 lb. per acre would be uneconomic the trial has been abandoned. Even the treated plants are little larger than they were when first treated 18 months ago.

Hormone Trials.—Planofix has given excellent results in the acceleration of fruiting. The first treatment was made in May, 1953, and the second in September, 1953. The object of the trial is to find out if it is possible, by using hormones, to advance the fruiting season and thus eliminate a great portion, if not all, the cold season fruits which often become infected with "Black Heart" disease. Table VII shows effect of the treatments on inflorescence production.

TABLE VII—EFFECT OF PLANOFIX IN ACCELERATING FLOWERING

CONCENTRATIONS	DATE TREATED				
	MAY, 1953			SEPTEMBER, 1953	
	Percentage of flowers produced at months after treatment				
	2	3	7	2	3
1 cc. : 500 cc.s	Nil	20.0	97.0	26.0	90.0
0.75 cc. : 500 cc.s	„	70.0	90.0	26.0	100.0
Control	—	Nil	6.0	35.0	40.0
0.5 cc. : 500 cc.s	Nil	30.0	76.0	17.0	96.0
0.25 cc. : 500 cc.s	„	20.0	59.0	16.0	96.0

The plants which originated from suckers had been planted a year before being treated and consisted of 23 to 32 leaves. Since the control plants showed no sign of flowering until 19 months after planting, it would appear the May treatment was premature though this supposition can only be proved by yields produced as a result of the treatment versus no treatment.

The September treatment shows that the hormone was applied at the time of natural flowering as indicated by the untreated control which shows that 35 per cent of the plants had flowered two months after treatment while a much lesser percentage of the treated plants produced flowers. At three months following treatment the hormone response was highly effective and very much more effective than the May treatment. Planofix at 0.75 ccs. in 500 ccs. appears to be the most effective concentration, as shown by the response to the treatments at three months after application.

Hormone trials carried out at the fruit station have been designed to test various hormones and it has been found that those containing naphthalene-acetic acid are superior. All the hormones tested, however, produced heavier fruits than the untreated plants provided treatment was made to plants of the right size. The fruit weight increase over the controls went up to as much as 28 oz., with the lowest favourable mean difference being 3 oz.

Weedicides.—Sodium Pentachlorophenate was used as a pre-emergence spray for weed control at 10 lb. and 20 lb. per acre. There was no control whatever at 10 lb. per acre, and only a very slight response to the 20-lb. per acre treatment.

Pentachlorophenol miscible oil has produced excellent results as a post-emergence weed killer. Applications were made at the rate of 2, 4, 5 and 8 per cent concentrations. The 4, 5 and 8 per cent concentrations effected complete kill but caused quite a lot of damage to leaf tissues though in no case were the heart leaves completely destroyed. As the treated plants were only six inches high at the time of treatment, little protection for the heart of the plant was afforded from the spray. At 2 per cent the spray was still highly effective with kill to both leaves and roots of the weeds with no visible damage to the pineapple plant at all. The predominant weed was nutgrass. As such a high degree of kill was effected at 2 per cent, it may be possible that even lower concentrations may be equally effective.

DEPARTMENTAL TRIALS

Coffee Research Station.—A trial has been planted on vlel soil which has been made up into raised beds of 24 ft. wide. The area of the trials is one-ninth of an acre. There are eight treatments replicated four times. Treatments are: nil; sulphate of ammonia; sulphate of ammonia and boma manure; sulphate of ammonia and superphosphate; sulphate of ammonia, superphosphate and boma manure; boma manure; superphosphate; superphosphate and boma manure.

Sulphate of ammonia is being applied at 10 cwt. per acre in two applications, superphosphate at 4 cwt. per acre and boma manure at 20 tons per acre.

Root washing of pineapple roots growing on red soil has recently been carried out on 14-month-old plants and 3½-year-old ratoon plants. The 14-month-old root system showed that the roots were concentrated in the surface layer of the soil, being composed of a compact flattened mat of roots three inches in depth. The mat was quite dense up to a radius of eight inches, when it commenced to thin out, reaching a maximum radius of 18 inches. The 3½-year-old ratoon plants produced a similar root pattern except that the thickness of the mat was greater, reaching a depth of six inches. In neither case was there a tendency for the roots to go deep. The tendency was to pack close, just below the surface. There was no suggestion of tap root development.

A miniature observational trial using Smooth Cayenne has been commenced at the Fruit Station on an area just cleared of a first ratoon crop. The area is on a bench terrace. The object of the trial is to study the effect of boma manure versus sulphate of ammonia on a replant area. Sulphate of ammonia is to be applied at 6 lb. per 100 plants and the boma manure at 5 tons per acre.

A similar trial using "Queen" type suckers has also been started but the boma manure has been applied at 10 tons per acre. This pineapple type has not yet fruited successfully at the station even though the plants have developed well. They have not responded to sulphate of ammonia treatment and as the type appears to prefer soil with a high humus content it is hoped that the boma manure treatment may prove successful.

SOIL CONSERVATION

During the long rains of 1953, the Assistant Soil Conservation Officer commenced a pineapple trial on a hillside to enable a study of soil conservation requirements of pineapples. The area was protected with narrow-base terraces and it has been found that the pineapples growing on the lower slopes of the terraced depressions have made little progress. A small observational, single plot, trial has therefore been started to study the influence of sulphate of ammonia on the pineapples growing in the area at the terrace depression. The following three levels of sulphate of ammonia are being tried: 3 lb., 6 lb. and 12 lb. per 100 plants.

OTHER UP-COUNTRY AREAS

Rongai.—The trial planted at Rongai in July, 1952, has now experienced two very dry seasons. Considering the weather conditions the rate of establishment has been high. The whole trial has now received a total dressing of sulphate of ammonia at the rate of 1,500 lb. per acre in three applications. Growth of the plants is irregular but plants on the two mulched plots have made more growth and are a better colour than those on the unmulched plots. Flowering has not yet started.

Kitale.—An observational trial about one-sixth acre in area was planted at the Kitale Fruit Sub-Station in July. The objects of this trial are a preliminary assessment of the effects of mulch and sulphate of ammonia on yield and resistance to drought, in the Kitale climate.

DEPARTMENTAL TRIALS, MATUGA, COAST PROVINCE

Pineapple Fertilizer Trial, Matuga

Varying rates of ammonium sulphate are being compared, applications having commenced at the end of 1951. Harvesting of first ratoon crop commenced at the end of last year, and although fertilizer had not been applied since November, 1952, its effects were still very obvious on the fruit.

Artificial Shade Trial on Pineapples, Matuga

This was commenced in the middle of the year with the planting up of Smooth Cayenne suckers in May, and shades, heavy, medium, light and nil applied early in June. By the end of the year there was a very obvious beneficial effect of heavy or medium shade on health of the plant. The heavy shade plots, in particular, gave a much larger and greener plant, while light and no shade has small, wilted plants, very chlorotic.

CO-OPERATIVE TRIALS, KILIFI

Co-operative Experiments

Experiment 1: Nitrogen, Phosphate, Potash Mulch.—This was commenced in 1952. The area had been planted up in March with crowns, first fertilizer applications were given in May with the final nitrogen application as sulphate of ammonia in June of last year. Phosphate and potash alone or together give very poor plants. Size and health of plant varies with colour, the darker healthy green plants being of larger size and generally healthy. Nitrogen and mulch give the best plants, while nitrogen, nitrogen and potash and nitrogen and phosphate have a dark colour but are not so healthy, the leaves being dark, with rather masked dark red and no good green. Flowering commenced on larger, healthier plots in September and the odd fruit was being harvested by the end of the year.

Experiments 2 and 3: Nitrogen, Phosphate, Potash and Mulch.—This was laid down during 1953, being more detailed than the above with three rates of nitrogen and two of phosphate. Colour variation was noted as soon as rain fell after application of fertilizers, nitrogen plots taking on a darker colour. Since applying fertilizers, colour variation was more marked in the open than under shade. Shade plants grew quicker and were generally a good healthy green, being slightly darker in nitrogen plots. By the end of the year all open plots showed plants with very red leaves, due to no rainfall during November and December. In nitrogen plots the redness was somewhat masked, leaves being dark but not a good green.

Experiment 4: Temporary Shade Tree Trial, 1953.—This trial was commenced with the rains in May–June of 1953 with the sowing of shade trees among pines. The pineapples had been planted up earlier in the year. Varying spacings were used for *Gliricidia maculata*, *Leucaena glauca* and *Sesbania*. The trial was not successful in that the shade trees did not come away satisfactorily and by the end of the year there was only the odd shade tree growing.

Experiment 5: Chemical Weed Control.—Observational trials were started with the use of a P.C.P. product as a pre- and post-emergence trial. It was seen from these that post-emergence spraying gives little result, while pre-emergence is more promising. No harmful effect was noticed on the pineapple plants.

Berry Fruits

Strawberries

The most successful variety so far in the Molo trials is "Cambridge Early Pine" (Cambridge 448). In order to make reasonable numbers of plants available to growers and nurserymen, an importation of 5,000 plants by air from England has been arranged. The consignment is expected to arrive during the long rains of 1954. As no certified virus-free stocks of this variety are being produced in England, it will be necessary to grow the plants in quarantine at Molo in order to comply with the Plant Quarantine Regulations. The quarantine period will provide an opportunity of multiplying the original consignment. Provided the plants pass through quarantine successfully, it should be possible to start issuing them during the long rains in 1955.

In view of the success at Molo of "Cambridge Early Pine" and Cambridge 449, a number of other Cambridge varieties are being imported for trial. The strawberry variety ex Tanganyika, mentioned in last year's report, has a better flavour than any other variety under trial. It is, however, proving rather susceptible to Strawberry Leaf Spot in the Molo climate and is unlikely to be suitable as a market variety.

Strawberries at Jacaranda

The following strawberries were planted for trial at Jacaranda: Eleanor Roosevelt x N.C.105; Eleanor Roosevelt x Massey; Auchincruive Climax.

Six plants each of the variety Cambridge Nos. 448 and 449 were planted during May, 1952. The plants came into bearing in October, continuing throughout November, December and half of January, 1953. The yield figure per plant was 7.6 oz. for No. 448 or 5,162 lb. per acre. No. 449 yielded 8.0 oz. per plant or 5,442 lb. per acre. The spacing was 2 ft. x 2 ft. Since planting, only the occasional runner has been produced. Although no Melba yields are available for the year under review, the yield of Melba during the previous year on a heavier rainfall was 6.0 oz. per plant or 4,083 lb. per acre.

Diseases

Symptoms of a physiological disorder of strawberries have occurred at Molo and it is suspected that the same trouble is occurring elsewhere. Some or all of the leaves on the plant become scorched and brown, in severe cases this is followed by death of the plant. The Senior Plant Pathologist has been unable to isolate any primary pathogens from affected plants but he has established that die-back of the roots occurs in early stages of the disorder. The symptoms are similar to those produced by waterlogging of the soil but this does not appear to be the cause at Molo. The disorder is suspected to be caused by a deficiency of magnesium; trials to test this theory are to be carried out.

Cape Gooseberry

A trial which was commenced during February, 1951, to determine whether the plants could be treated as perennials and over what period, has been concluded. The seeds were sown in a nursery and plants transplanted into the field at a 4-ft. x 4-ft. spacing. After each fruiting season the plants were cut back to within six inches of their base, the trash being left to lie between the rows as soil cover. Two very good crops were produced during the first two years but following the third pruning, many of the plants failed to re-establish themselves. Those which did, made very little growth and subsequently the fruit crop was negligible.

The results show that the cape gooseberry may be treated as a perennial. The low rainfall during 1953 may have contributed to the failure of the plants to re-establish themselves after cutting back for the second time and consequently, it may be possible to extend the life of the plant where rainfall conditions are more favourable or by irrigation. Yield results produced 5,272 lb. per acre on a rainfall of 34.75 in. during the first year and for the second year 6,124 lb. per acre was produced on a rainfall of 37.93 in. Mean yield per plant over the total fruiting period was 2 lb. 1 oz. A further trial to study the effect of irrigation on yield and longevity has been commenced.

Vegetables

Jacaranda

A wide range of vegetable trials was conducted during the year and the results which follow are based on single plot performance.

TABLE VIII

Kind	Variety	Date sown	Harvesting completed	Spacing	Mean weight per head, fruit or root	Yield per acre	Rainfall	Irrigation	Remarks
Lettuces ..	Newest Winter	22-10-52	2-3-53	18" x 9"	4.9 oz.	<i>Tons lb.</i> 3 880	<i>in.</i> 7.85	<i>in.</i> 13.0	
Lettuces ..	Unrivalled Summer	29-10-52	3-3-53	18" x 9"	7.5 oz.	6 1,000	7.85	13.0	
Lettuces ..	Bavarian Brown Curled	29-10-52	20-2-53	18" x 9"	7.3 oz.	6 873	7.53	13.0	
Lettuces ..	May King	29-10-52	2-3-53	18" x 9"	5.0 oz.	3 1,171	7.85	13.0	
Lettuces ..	White Pearls	29-10-52	20-2-53	18" x 9"	6.6 oz.	5 200	7.53	13.0	
Chinese Cabbage	Kai Choy	29-10-52	12-1-53	18" x 18"	1 lb. 3 oz.	7 1,618	7.53	10.5	
Chinese Cabbage	Pak Choy	—	—	—	—	—	—	—	Failed owing to early bolting.
Endive ..	Green Curled Summer	29-10-52	25-3-53	12" x 12"	10.1 oz.	8 106	7.85	13	
Turnip ..	White Milan Extra Early	29-10-52	23-1-53	18" x 6"	6.0 oz.	7 659	7.53	2.5	
Spinach	Monstrous Viroflay	29-10-52	23-1-53	24" rows	—	3 25	7.53	10.0	
Beetroot	Egyptian Early Flat	29-10-52	4-3-53	24" x 9"	11.0 oz.	7 1,357	8.41	11.5	
Beetroot	Early Blood Red Turnip	20-10-52	—	24" x 9"	11.4 oz.	6 754	8.41	11.5	
Carrot ..	Dutch Horn (unthinned)	29-10-52	23-3-53	18" rows	1.6 oz.	11 722	8.91	13.0	
Carrot ..	Dutch Horn (thinned)	29-10-52	23-3-53	18" x 2"	2.8 oz.	7 761	8.91	13.0	
Carrot ..	Oxheart (unthinned)	29-10-52	16-3-53	18" rows	2.3 oz.	20 787	8.91	13.0	
Carrot ..	Oxheart (thinned)	29-10-52	16-3-53	18" x 2"	4.8 oz.	10 1,473	8.91	13.0	
Carrot ..	Half Long Nantes	—	—	—	—	—	—	—	
Carrot ..	Half Long Nantes thinned	29-10-52	30-3-53	18" rows	1.7 oz.	13 492	8.91	13.0	
Carrot ..	Half Long Nantes (thinned)	—	30-3-53	18" x 2"	4.6 oz.	8 1,824	8.91	13.0	
Parsnip	Guernsey Half Long	29-10-52	31-4-53	24" x 9"	5.2 oz.	4 1,379	9.61	20.0	
Radish ..	Turnip Early Scarlet	29-10-52	19-12-52	12" rows	—	2 63	5.39	4.0	
Radish ..	French Breakfast	29-10-52	19-12-52	12" rows	—	4 1,443	5.39	4.0	
Aubergine	Early Long Purple	29-10-52	31-4-53	24" x 24"	3.5	6 266	9.61	20.0	

TABLE VIII—(Contd.)

Kind	Variety	Date sown	Harvesting completed	Spacing	Mean weight per head, fruit or root	Yield per acre	Rainfall	Irrigation	Remarks
Parsley ..	Very Dwarf Cress	29-10-52	16-6-53	12" x 6"	—	Tons lb. 1 642	in. 15.53	in. 20.0	Mean yield per plant 4 lb. 4 oz.
Cucumber ..	Borinial	30-12-52	20-2-53	48" x 48"	6.0	5 363	7.59	10.5	Mean yield per plant 3 lb. 10 oz.
Cucumber ..	Long English Prickly ..	30-12-52	20-2-53	48" x 48"	4.4	4 1,105	7.59	10.5	Mean yield per plant 2 lb. 14 oz.
Cucumber ..	Small Paris Gherkin ..	30-12-52	5-2-53	48" x 48"	5.6	3 1,100	7.59	8.91	
Leeks ..	London Flag	28-10-52	14-5-53	30" rows	5.2 (trimmed)	3 1,153	15.33	17.0	
Leeks ..	Monstrous Clarenton ..	28-10-52	14-5-53	30" rows	4.4 (trimmed)	2 1,674	15.33	17.0	
Celery ..	Yellow French Floride	1-10-52	15-7-53	12"x 12"x 72"	11.3	1 1,665	24.49	16.5	Planted in trenches in double rows.
Celery ..	Dwarf Large Ribbed White Solid.	1-10-52	15-7-53	12"x 12"x 72"	1 lb. 2 oz.	2 1,642	24.49	16.5	Planted in trenches in double rows.
Celeriac ..	Paris Improved ..	28-10-52	21-8-53	18" x 18"	9.3 oz.	6 384	24.49	13.5	
French Beans ..	Noord Holland ..	13-10-52	5-2-53	24" x 12"	—	304	6.77	4.0	Yield is given as dry beans.
French Beans ..	Exponent	13-10-52	5-2-53	24" x 12"	—	384	6.77	4.0	Yield is given as dry beans.
French Beans ..	Beka	13-10-52	5-2-53	24" x 12"	—	425	6.77	4.0	Yield is given as dry beans.
Lima Bean ..	Burpees Best Pole ..	30-3-53	30-11-53	48" x 12"	—	897	13.94	4.5	Mean yield per plant 4.4 oz. (dry).
Sweet Corn ..	Hawaiian Sweet ..	28-3-53	31-8-53	—	6.8 oz. (cob)	—	17.78	12.0	Mean yield per plant 1.9 (cobs).

Lettuce, Newest Winter

A cabbage type lettuce, the largest of which reached a diameter of 12 inches. The plants did not heart up very well and leaves were soft. Stood well

Lettuce, Unrivalled Summer

A cabbage type lettuce. Small heads with a diameter of nine inches. Hearts up reasonably well and stands better than any of the other varieties listed.

Lettuce, Bavarian Brown Curled

A Cos variety. Sizes up well but commences to flower early and consequently will not stand.

Lettuce, May King

A cabbage variety which reached a diameter of 16 inches in some cases. The plant does not heart up very well but stands well.

Lettuce, White Paris

A Cos variety which flowered prematurely and has a whitish mildew-like down upon the leaves making the plant unattractive for sale purposes.

Chinese Cabbage, Kai Choy

Plants tend to produce flowers quickly on reaching maturity and consequently will not stand.

Chinese Cabbage, Pak Choy

This plant was a complete failure. Flower heads were produced one month after sowing and long before the plants had made any size.

Endive, Green Curled Summer

Average diameter per head was 12 inches. Heads were firm but on approaching the true hearting-up stage, tended to show signs of producing flower heads.

Spinach, Monstrous Viroflay

Had it not been for severe chlorosis which developed after the third harvest, the yield would have been considerably more. Nitrate of soda was applied at the rate of 500 lb. per acre immediately the plants showed symptoms of chlorosis but this failed to produce any response and the crop was abandoned. Density in the rows may have induced chlorosis as a result of competition.

Beetroot, Egyptian Early Flat and Early Blood Red Turnip

With a full stand, the variety Early Blood would have produced a higher yield than the Egyptian Early Flat. Both varieties stood extremely well.

Parsnip, Guernsey Half Long

There was evidence of a scab-like effect on the roots but this did not penetrate the flesh which was quite attractive when prepared for use.

Radish, Turnip Early Scarlet

There were 86 roots per pound but this was rather on the large size for convenient marketing bunches.

Radish, French Breakfast

There were 53 roots per pound which made a most suitable 12-bunch for marketing.

Aubergine, Early Long Purple

Many of the fruits were up to seven inches in length with a diameter of two inches and most uniform in shape.

Parsley, Very Dwarf Cress Curled

The individual stalks were of a nice size, measuring up to eight inches in length. A useful sized bunch contained 14 stalks with each bunch weighing four ounces.

Cucumber, Boriniel

The largest fruits measured up to eight and a half inches in length. Very pale, chlorotic looking skin though flesh of excellent flavour.

Cucumber, Long English Prickly

The largest fruit measured up to seven inches. Good colour and of uniform shape.

Cucumber, Small Paris Gherkin

The largest fruits measured up to six and a half inches.

Celery, Dwarf Large Ribbed White Solid and Yellow French Floride

Dwarf Large was the much better variety of the two grown. It stands well and is the more attractive when prepared for market. Tends to suffer from leaf scorch when under sprinkler irrigation.

Celeriac, Paris Improved

The heaviest roots weighed as much as $1\frac{1}{2}$ lb. with a diameter of four inches. At this size, however, the roots became hollow in the centres and the flesh became very stringy.

Beans, Noord Holland, Exponent and Beka

The three varieties Noord Holland, Exponent and Beka were sown on the front half of bench terraces where the soil was more fertile. No previous crops had been cultivated but the land, prior to bench terracing, had suffered as a result of squatter cultivation four years earlier.

Beans, Stringless Red Valentine

The yield figures in this trial produced interesting results. The trial, like the earlier ones, was grown on unfertilized bench terraces but in this case the trial area passed through the site of a former cattle pen. The pen, together with the manure, had been removed three years previously and before bench terracing had been undertaken. The yield figure given above represents the yield outside the area of the cattle pen but the yield inside the pen was 1,232 lb. per acre.

Lima Bean, Burpees Best Pole

The climbing type of bean requires a considerable amount of attention. Bamboo stakes were used to support the plants and these stood extremely well though it was found that firm bedding into the soil was necessary to avoid collapse during high winds and rains.

Sweet Corn, Hawaiian Sweet

The variety is a popular canned product in the U.S.A. The crop was grown on soil which had received a dressing of compost at the rate of 10 tons per acre.

Brassicas

The varieties listed in Table IX were sown in the nursery on 7th January and transplanted to the fields at 2-ft. square spacing on 18th February. During growth they received 15.43 inches of rain and the equivalent of another 15 inches as irrigation.

TABLE IX

TYPE	VARIETY	HARVESTING		Mean weight per head	Yield per acre	
		Com-menced	Com-pleted			
				lb. oz.	Tons	lb.
Cabbage ..	Foffler's Improved ..	25-4-53	21-5-53	3 8	17	30
Cabbage ..	Exheart Early	24-4-53	21-5-53	2 10	12	1,712
Savoy ..	Verhue's Drumhead ..	25-4-53	21-5-53	2 14	13	1,181
Cauliflower	Phenomenal Twelveweeks	2-5-53	21-5-53	1 15	9	937
Cauliflower	Early Greenglaze ..	10-6-53	1-7-53	1 11	1	822
Cauliflower	All Year Round	2-5-53	26-5-53	2 3	10	1,429
Cauliflower	Phenomenal	7-5-53	12-8-53	1 11	8	450
Cauliflower	Maincrop	—	—	—	—	—
Cauliflower	Southern Crop	19-5-53	4-8-53	1 14	9	52
Broccoli ..	Mammoth White ..	17-6-53	12-8-53	1 12	8	1,135
Broccoli ..	Extra Early White ..	10-7-53	8-8-53	2 3		40

The broccoli variety, Extra Early White, was a complete failure. The plants made good growth and the stand was excellent. On reaching maturity the stem became leggy and crowned with small leaf clusters with no hearting up. Early Greenglaze Cauliflower was also of little value. It proved very difficult to establish and tended to become drawn and leggy. This particular trial was interesting in that it was established in the field during the middle of the hot dry season by means of sprinkler irrigation. No sign of scorching was observed and no shade was used to assist establishment.

As there had never been any significant response to nitrogenous fertilizers on previous cabbage trials at 500 lb. per acre, a trial was put down to study the effect of increased applications of sulphate of ammonia and nitrate of soda at 1,000 lb. per acre, but only small increases were obtained and these were quite uneconomic.

Tomato

The varieties listed in Table X were sown on 25th July, 1952, transplanted to the field on 15th September, and harvested between 21st November and 13th January. During growth they received 11.54 inches of rain and the equivalent of another 9.5 inches as irrigation.

TABLE X

VARIETY	UNPRUNED 4 ft. x 4 ft.		PRUNED 2 ft. x 2 ft.	
	Yield per acre	No. of Fruits per lb.	Yield per acre	No. of Fruits per lb.
	<i>Tons lb.</i>		<i>Tons lb.</i>	
San Marzano	8 1,470	9.7	5 2,103	8.9
No. 12	3 59	4.7	5 1,716	4.9
66-16	9 1,892	5.3	8 1,250	6.7
No. 255	6 2,213	4.8	7 1,141	5.5
Pearson	6 1,198	5.3	6 1,819	5.4
Lanai	6 342	3.0	7 1,142	5.5
Oahu	6 1,319	4.9	5 1,710	5.3
Kauai	4 1,970	5.1	8 14	5.3
Nishau	3 1,956	4.6	6 2,211	5.1
Hawaii	8 79	6.0	7 1,637	5.7
Maui	4 2,190	5.6	6 1,422	6.2

Before planting, an application of 10 tons of compost per acre was made. The unpruned plants were allowed to grow at will with no stakes being provided. The pruned plants were left to a single cordon and were tied to a stake. Results show that certain varieties do better when treated as staked, single cordon plants. Commercially, it is probably better and cheaper to cultivate the varieties which are suited to bush culture.

Onions

In order to confirm previous good results at Molo with the Texas Grano variety, further trials were carried out at Molo and Jacaranda. The results, which are given in detail below, confirm that this variety is most suitable for Kenya conditions. Although storage trials are not complete, the indications are that onions grown and stored at comparatively low altitudes (Jacaranda), will keep longer without deterioration than at high altitudes (Molo).

At Molo, 8,300 ft., sowing was done on 8th July, and a plot of 0.313 acre was established at a spacing of 12 by 4 inches. Rainfall during growth was 19.5 inches. Harvesting was done between 25th October and 1st March and the yield was 6.275 tons per acre. The seed was sown direct using a Planet Junior planter. Owing to dry weather following sowing, germination was poor and uneven, which gave a very variable spacing in the row. This resulted in an uneven growth of the plants and at harvest time there was a great variation in size of bulbs. Some bulbs were still not ripe when the long rains broke at the beginning of April. Although this was due partly to unfavourable weather conditions earlier in the season, it is considered that the sowing date, 8th July, was too late where the crop takes so long to mature.

At Jacaranda, 5,400 ft., sowing was done on 19th August and the spacing was again 12 by 4 inches. Harvesting took place between 23rd December and 18th January and the yield was 9.6 tons per acre. Rainfall during growth was 11.29 inches and was supplemented by 13.5 inches of irrigation. The crop was made up of 66 per cent Grade I (average weight per bulb, 4.4 oz.) and 34 per cent Grade II (average weight per bulb, 1.4 oz.).

The trial was commenced under irrigation and brought through to the short rains season entirely by irrigation which was carried out at five-day intervals. Following the short rains, the crop was allowed to ripen off. Soil was frequently removed from the base of the bulbs until they sat freely on the soil surface.

When the seedlings were about six inches high they were thinned, the thinnings being transplanted to another plot to enable comparison with those sown direct. Transplanting took place on 15th October to the same spacing as in the direct sown trial. Rainfall was 5.61 inches, supplemented by 6.0 inches or irrigation before transplanting and 10.0 inches afterwards. Harvesting was done between 2nd and 15th February and the yield per acre was 12 tons. Grade I bulbs (average weight 5.0 oz.) formed 75 per cent of the crop and Grade II (average weight 2.1 oz.), 25 per cent.

No disease was observed among either crop but thrips became troublesome during mid-November though a considerable measure of control was effected by D.D.T. Wettable Powder, 33½ per cent in an 0.5 per cent concentration.

Storage of bulbs, in an aluminium-roofed shed with sisal-pole walls, from both crops is still in progress. Before being placed in store, the bulbs were sun dried for 11 days. The direct sown bulbs have now been stored for 77 days. At the end of two months, 8 per cent had to be discarded but there is still no sign of deterioration among the remainder. The sample was roped and hung from a beam. The mean maximum and minimum centigrade temperatures in the immediate vicinity of the hanging ropes, 6 ft. above the floor, was 27° and 18°. The Centigrade temperature of the store, recorded 2 ft. above floor level and in the centre of the store was 27° and 19°.

Bulbs from the transplanted trial were also dried off in the sun for 11 days prior to storage. In this case storage was in flat crates in a single layer, placing the crates on the roof joist beams. Following 35 days of storage 7.5 per cent have been discarded due to deterioration. The remainder show no signs of deterioration. The centigrade temperatures during storage show a mean maximum and minimum of 27° and 19°. The temperature range seems to indicate that deterioration is not attributable to temperature. Air flow may, however, play an important part because light intensity is believed to be the same for both roped and crated samples.

Shallots

A trial with shallots, which we believe have not previously been tried in Kenya, was carried out at Molo, 8,300 ft. Setts of the variety Yellow Shallot were imported by air from Britain and were planted on 13th May. A mass of shoots was produced but no bulb formation occurred. It is believed that the variety used is a long-day plant and failed on account of the short day length in Kenya. Similar results have previously been obtained with long-day varieties of onions.

Pea

Trials of 6 pea varieties for seed received from the Research Institute, Wageningen, Holland, were carried out at Molo, altitude 8,300 ft. A previous trial of pea varieties for seed had been carried out in 1950 in co-operation with The United Africa Company (Kenya), Ltd., and was considered successful. The present trial was designed to confirm previous results, including a number of new varieties.

Light volcanic loam of a good depth was chosen for the trial, each variety covering roughly 1/10-acre. This area had been under oats for green manure purposes in previous years and had carried a crop of maize in the last season. The varieties under trial were: Mansholts Pluk, Unica, Servo, Immigrant, Rondo C.B., and Zelka. Ten pounds of seed was received of each variety and sown at the rate of 100 lb. per acre, using a Planet Junior for sowing. All varieties were treated with Agroxan before sowing, which commenced on 18th August, 1953, and was completed on 24th August, 1953. An excellent germination of all varieties was observed at the beginning of September with 2.00 in. rain between the date of sowing and time of germination. After this, rain ceased almost completely. However, good growth was made. Green aphid attacked all plots, the varieties Zelka and Mansholts Pluk being particularly badly infested. A D.D.T. spray was applied on 27th October, 1953, and controlled the aphid successfully. In November, quite unusual rain was experienced combined with very dull weather. All pea varieties had started to pod well but at the end of the month pods showed dark stains with discolouration of the individual peas in the pods. This was thought to be due to the effect of rain and too little sun, particularly as also Mildew attacked the plots. Specimens were sent to the Scott Agricultural Laboratories, Nairobi, and the identification revealed the presence of the fungus *Ascochyta pisi*. It was noted that Rondo and Immigrant appeared to be almost free from Mildew. Harvesting started on 18th December, 1953: Mansholts Pluk and Unica having ripened off very well in spite of pests and diseases.

YIELD FIGURES

				<i>Lbs. per Acre</i>
Mansholts Pluk	...	..	..	1,777.9
Unica	..	..	..	2,511.4
Servo	..	..	..	1,801.8
Immigrant	..	..	..	846.0
Rondo C.B.	..	..	..	1,313.0
Zelka	..	..	..	1,268.8

All varieties showed a certain percentage of discoloured peas owing to the fungus *Ascochyta pisi*.

The Ministry of Agriculture and Fisheries Bulletin, No. 81 of 1949 ("Peas for Market, Canning and Drying"), states on page 19: "The yields of dried peas vary considerably. They commonly range from 15-25 cwt. per acre, a fair average being 20 cwt." With the exception of Immigrant all the varieties under trial compare quite favourably with this statement. Comparison of yield figures with a previous trial grown for seed is as follows:—

				1950 <i>lb.</i>	1953 <i>lb.</i>
Unica	..	..	..	2,049	2,511.4
Mansholts Pluk	..	..	..	1,411	1,777.9

Excluding the variety Immigrant, all varieties are promising, classing Unica and Mansholts Pluk as successful. Servo should be grown again to confirm the present good result. Samples of each variety are to be submitted to local canneries for canning trials.

Asparagus

The observational trial with Mary Washington Asparagus, to determine the best cutting season or seasons, which was described in the Annual Report for 1952, yielded as follows:—

Plot	No. of Cutting Seasons	Spacing	YIELD		Total Yield
			7-4-53 to 28-4-53	11-9-53 to 26-10-53	
1	2	4 ft. x 1½ ft.	lb. 22·5	lb. 77·5	lb. 100
2	1	4 ft. x 1½ ft.	—	61·0	61
3	2	7 ft. x 1 ft.	40	169·25	209·25
4	1	7 ft. x 1 ft.	—	125	125

The total area of the trial is approximately 1/7-acre, thus the total yield for the year 1953 is at the rate of 3,465 lb. per acre.

Miscellaneous Crops*Fibre Plants*

A report received from the Imperial Institute on the sample of fibre prepared from Mallow (*Malva verticillata*) indicates that this fibre is of little or no commercial value. Plots of *Abutilon longicuspe* were harvested in December, 1953. Yields were as follows, from plots of 1/10-acre:—

Plot	Row Spacing	Green Weight	Dry Weight
	<i>in.</i>	<i>lb.</i>	
E.4 ..	7	2,341	712
E.6 ..	14	1,493	—
E.23 ..	21	1,419	—
E.25 ..	21	1,654	529
E.27 ..	7	2,599	822
E.33 ..	14	3,109	977

There appears to be no significant difference in green weight yield due to row spacing but at the closer spacing there was much less side branching. Differences in yield are due to variations in fertility of the land where the trial was planted, to which this crop is very susceptible. A sample of fibre is now being prepared for testing. *Abutilon longicuspe* is a perennial and it is considered that after the first season, which is devoted to establishing the plants, one or even two cuts per year could be taken for a number of years from the same stand of plants.

Acknowledgments

In conclusion I wish to thank the staff of the Horticultural Section for the large volume of excellent work carried out during the year in spite of difficulties created by the Emergency. I should also like to thank members of other sections of the Department for their co-operation and help, in particular Mr. J. Robinson (Soil Chemist) Coffee Services, for interpretations of results of pineapple fertilizer trials.

T. H. JACKSON,
Agricultural Officer (Hort.).

APPENDIX A

1953 IMPORTS OF FRUIT TREES THROUGH KILINDINI

Origin	No. Packages	Value	Increase	Decrease over 1952
		<i>Sh.</i>		<i>Sh.</i>
South Africa	424	68,611	—	32,454

APPENDIX B

1953 IMPORTS OF FRESH FRUIT THROUGH KILINDINI

Kind	Origin	No. Packages	Value	Increase*	Decrease* over 1952
			<i>Sh.</i>		
Apples ..	Italy ..	19,820	721,721	35,008	—
	Holland ..	200	9,140	2,290	—
	U.K. ..	905	36,819	—	65,195
	South Africa	1,005	29,399	6,531	—
	Australia ..	1,452	140,890	119,676	—
Grapes ..	South Africa	11,033	142,250	53,799	—
	Italy ..	774	21,660	21,660	—
	France ..	495	12,203	7,278	—
	Spain ..	2,052	120,810	45,121	—
Pears ..	Italy ..	1,567	49,452	49,452	—
	U.K. ..	40	1,572	1,572	—
	South Africa	560	16,400	9,445	—
Citrus ..	South Africa	5,130	179,581	33,383	—
Bananas ..	E.A. Ports ..	8,342	116,070	—	77,915

Total Value Imports Sh. 1,598,067

Net Increase Sh. 142,105

*Increase or Decrease in value (Sh.) over 1952.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (PYRETHRUM), 1953

Meteorological

Rainfall in 1953 again was well below the average in most pyrethrum growing areas. Yields per acre were low in general and the total production in the Colony amounted to 4,547,270 lb. only, 970,227 lb. less than in 1952. On the other hand, the pyrethrin content with 1.60 per cent was considerably higher than in previous years. It is difficult to account for this phenomenon, as generally the content seems to rise with higher rainfall and a consequent drop in temperatures, factors which did not apply during 1953.

Rains started about the middle of April and planting was undertaken immediately on the Experimental Stations. May, June and July were, however, comparatively dry again and further plantings suffered from the uneven distribution of the rainfall. In Molo, fortunately, some unexpected rains fell in December which prolonged the picking season.

Detailed meteorological records for the various Experimental Stations are appended.

Experimental Work

(Trials reported in Part II: 2 of this Section's Annual Report for 1952 and not included in Part II: 2 of the current Report have either been concluded or discontinued.)

(a) LARGE ROTATION TRIAL

Reference is made to Part II: 2 (f) and Part II: 2 (a) of this Section's Annual Reports for 1951 and 1952 respectively, in which the design and the object of this trial were explained.

During the 1953/54 season, fertilizers applied to the pyrethrum plots again have shown no effect on the yield. There were, however, indications that the yields of the plots planted with continuous pyrethrum began to decline after the seventh year of cropping as compared to pyrethrum which followed a grass ley. In previous years, no deleterious effect on the yield through continuous pyrethrum cropping could be detected. It is possible that the deterioration in physical soil condition which takes place under this treatment, combined with the effect of two dry seasons (1952 and 1953) have brought about a change in the position.

The trial will be continued for at least two more seasons.

(b) PICKING/STRIPPING TRIAL, 1951

Reference is made to Part I: 5 (b) and Part II: 2 (d) of this Section's Annual Reports for 1951 and 1952 respectively.

This trial has covered three seasons and it is intended to discontinue it, as it has given fairly consistent results over this period. It was designed as a split-plot experiment with three varieties of pyrethrum (C.1, C.47 and unselected Bulk) and four treatments (2-weekly selective picking and 2-weekly, 3-weekly and 4-weekly stripping). It was found that selective picking held no advantage over stripping. On some occasions 2-weekly or 3-weekly stripping have increased the yield of pyrethrins significantly over selective picking and 4-weekly stripping.

The yields, in lb. pyrethrins per acre, for the three seasons were as follows:—

A—VARIETIES								
					1951/52	1952/53	1953/54	Total
C.47	..	..	..	..	27.17	24.48	23.40	75.05
Bulk	..	..	..	..	17.03	16.55	17.21	50.79
C.1 (14 x 24)	..	..	..	..	15.65	16.34	18.42	50.41

C.47 yielded significantly ($P = 0.01$) better than the other two varieties in the first two seasons but not in the last one.

B—TREATMENTS								
					1951/52*	1952/53†	1952/53‡	Total
2-weekly picking	..	..	..	..	19.66	18.27	19.48	57.41
2-weekly stripping	..	..	..	..	20.82	20.87	20.79	62.48
3-weekly stripping	..	..	..	..	21.20	19.48	20.23	60.91
4-weekly stripping	..	..	..	..	18.25	17.89	18.21	54.35

* 3-weekly stripping was significantly ($P = 0.01$) better than 4-weekly stripping;
 3-weekly stripping was significantly ($P = 0.05$) better than 2-weekly picking;
 2-weekly stripping was significantly ($P = 0.05$) better than 4-weekly stripping.

† 2-weekly stripping was significantly ($P = 0.05$) better than 2-weekly picking and 4-weekly stripping.

‡ Not significant.

In view of these results it is felt that the grower can safely adopt the method of stripping his flowers at two or three weeks intervals instead of taking the extra pains of selective picking.

(c) FERTILIZER/MULCH TRIALS

Reference is made to Part I: 5 (c) in this Section's Annual Report for 1952.

The trials were established at Molo, Subukia and Ol Joro Orok in 1951, designed as 2^s factorial experiments.

The treatments were: 80 lb. per acre sulphate of ammonia; 100 lb. per acre muriate of potash; 150 lb. per acre triple superphosphate, applied in the planting holes; 10 tons per acre farmyard manure; and mulch.

Sulphate of ammonia and muriate of potash have been reapplied at the beginning of each season and mulch has been renewed so that there was always a layer of about 4 in. thickness.

Nitrogen and potash had no effect in any of these trials. Mulch decreased the yield significantly ($P = 0.01$) at Molo during the first season, 1951/52, but no effects were observed in the next two seasons. It is thought that the exceptionally heavy rains which fell in 1951 retarded the growth of the splits under the mulch. At Subukia, mulch increased the yield significantly ($P = 0.05$) by 85 lb. per acre during the third season only. Both the 1952 as well as the 1953

seasons were droughty and it may be that the accumulative effect of mulch became more pronounced under these conditions. At Ol Joro Orok, mulch gave significant increases ($P = 0.01$) of 61 and 115 lb. per acre respectively during 1952 and 1953. Again, the scanty rainfall on this station during these two seasons may have enhanced the effect of mulch. Whether these increases justify the application and maintenance of mulch over three seasons is possibly a moot point. In none of the three trials either superphosphate or farmyard manure have affected the yield. The experiments will be discontinued.

Plant Breeding

During the 1953/54 season, 705 single plant selections have been under observation on the various Experimental Stations. A high percentage of these had been selected within hybrids (crosses) produced on the stations. It is the policy, in future, to select clones mainly within hybrids of known origin and only in exceptional cases within unselected bulk pyrethrum. A number of tested and promising clones were bulked up at Molo, Marindas and Subukia. Before these are used either for crossing or for a direct issue to growers it seems essential that they be examined for their biological efficacy and the necessity of insecticidal tests as part of the breeding work cannot be stressed enough.

New hybrids (crosses) bred on the various stations were tested in 11 yield trials, started in 1951, 1952 and 1953 respectively. A constant improvement has taken place in vigour as well as in yields of pyrethrins over the first crosses made and in various trials C.43 (145 x P) and C.51 (127 x 481) have shown themselves superior to both C.1 and C.47, while C.57 (194 x 486), C.77 (468 x 486), C.79 (468 x P) and M.9 (468 x 1226) may possibly give a further improvement. C.43, C.51, C.77 and C.79 have also shown adaptability to different altitudes. Before any new seed issues could be made, however, it would be desirable to have these new hybrids tested for their insecticidal properties.

Work on the "sugar-beet" breeding system, started at Molo in 1951, was continued in isolated plots at Molo and Subukia.

Twenty new crosses with two parent clones each were made in isolated plots at Molo and Ol Joro Orok. Two of these were planned on a system of line breeding and three are back crosses to one of the original parents.

Altogether $6\frac{1}{2}$ acres of seed production fields of C.47 were maintained, but no seed was issued from these because of the doubt shed on the biological efficacy of this hybrid.

Further seed production fields were:—

C.43.—One acre at Molo Experimental Station.

C.51.—One acre at the Grassland Station, Marindas.

Mixed Cross.—One acre at the Grassland Station, Marindas.

1970 Control.—Two acres at Molo Experimental Station.

Apart from these varieties, a certain quantity of seed was harvested from vigorous plants at the different stations and issued under the name of "Molo Bulk", "Ol Joro Orok Bulk" and "Subukia Bulk". The Experimental Stations supplied altogether 844 lb. of seed to the Pyrethrum Board.

Dr. Kroll, while on long leave, visited the natural habitat of *Pyrethrum cinerariaefolium*, i.e. the Dalmatian coast, and collected a certain amount of seed from wild and cultivated plants. It is hoped that amongst the seedlings originating from this material some will be found which have qualities of vigour and disease resistance which can be utilized in the plant breeding work.

Pests and Diseases

The incidence of Bud Disease (caused by the fungus *Ramularia bellunensis*) was higher during the 1953/54 season than in the foregoing one. This was not only apparent when visiting growers' fields but is borne out by the regular counts of diseased buds made within the single plant selections and other relevant field trials.

The disease rates in the selections at Molo and Ol Joro Orok were as follows:—

		1952/53	1953/54
		per cent	per cent
Molo	.. ..	3.8	7.6
Ol Joro Orok	.. ..	5.1	8.7

It is difficult to account for the increase in this fungus disease. Both years were dry, especially at Ol Joro Orok, and one would not think that the humidities prevailing were particularly favourable for the germination of the spores. There was also no appreciable difference between the monthly mean temperatures of the two seasons.

The Plant Physiologist of the East African Agriculture and Forestry Research Organization carried out further trials with copper sprays at Molo, the results of which have been incorporated in his report.

Acknowledgments

Acknowledgments are gratefully made to members of the Pyrethrum Research Advisory Committee and to Messrs. N. Hardy and W. J. Lucking of the Pyrethrum Board for their unfailing assistance throughout the year.

Thanks are due to Mr. J. Glover, Plant Physiologist of the East African Agriculture and Forestry Research Organization, and to Dr. R. M. Nattras, Senior Plant Pathologist, for their help in the investigation of Bud Disease problems, to Messrs. V. A. Beckley and J. Hopkins for a great number of analyses carried out in connexion with breeding and field experiment work.

Appreciation is extended to Messrs. Allison, Prentice, Polhill, Pope, Whetham and Barnett for kindly making land available for experimental purposes and helping with the recordings of the trials on their farms.

U. KROLL,
Agricultural Officer (Pyrethrum).

APPENDIX

METEOROLOGICAL DATA

(a) MOLO (ALTITUDE 8,300 FT.)—

1953	Mean Temp. °F.	Rainfall	Sunshine
		<i>in.</i>	<i>hrs.</i>
January ..	57·6	0·34	275·7
February ..	57·9	0·08	262·9
March ..	59·1	1·34	271·4
April ..	59·5	3·90	237·2
May ..	57·2	4·07	253·6
June ..	56·6	5·63	183·8
July ..	54·5	3·05	238·0
August ..	54·9	5·58	166·3
September ..	55·7	1·90	211·5
October ..	57·1	3·03	230·7
November ..	56·9	2·86	172·3
December ..	57·5	4·08	237·4
Mean ..	57·0	35·86	2,740·8

(b) MARINDAS (ALTITUDE 9,200 FT.)—

1953	Mean Temp. °F.	Rainfall	Sunshine
		<i>in.</i>	<i>hrs.</i>
January ..	56·1	0·38	238·1
February ..	57·3	0·00	234·9
March ..	57·5	0·52	251·4
April ..	57·4	4·32	191·9
May ..	55·8	2·49	195·8
June ..	53·8	5·18	148·0
July ..	52·2	3·82	184·7
August ..	52·5	6·66	131·5
September ..	54·2	2·02	209·8
October ..	55·8	1·65	215·9
November ..	54·6	2·83	168·9
December ..	—	2·29	94·7
Mean ..	55·2	32·16	2,265·6

(c) SUBUKIA (ALTITUDE 7,000 FT.)—

1953	Mean Temp. °F.	Rainfall	Sunshine
		<i>in.</i>	<i>hrs.</i>
January ..	63·1	0·20	—
February ..	63·7	0·10	—
March ..	65·8	0·12	—
April ..	63·5	4·88	—
May ..	61·2	5·31	121·1*
June ..	61·3	4·34	169·3
July ..	60·1	5·33	83·4*
August ..	60·3	3·15	199·4
September ..	60·6	2·14	112·8*
October ..	61·2	4·83	208·3
November ..	60·9	3·76	158·5
December ..	62·8	1·27	229·1
Mean ..	62·0	35·43	

*Incomplete.

(d) OL JORO OROK (ALTITUDE 7,800 FT.)—

1953	Mean Temp. °F.	Rainfall
		<i>in.</i>
January	55·8	0·42
February	56·5	0·04
March	57·9	0·76
April	58·2	4·08
May	55·1	4·21
June	55·4	3·64
July	53·0	4·90
August	54·1	4·68
September	54·2	1·55
October	55·3	1·27
November	55·9	3·36
December	55·9	1·18
Mean	55·6	30·09

ANNUAL REPORT OF THE SENIOR CHEMIST (PYRETHRUM), 1953

Again there has been a change in the trend of investigation. Last year much emphasis was placed on a careful study of sampling technique. Early during the year it became apparent that laboratory investigation had gone as far as required, some mechanical means of implementing the recommendations was needed, especially for grading samples. The Pyrethrum Board has been experimenting, with our collaboration, and has succeeded in evolving a simple machine which delivers replicate samples in successive passages of the same lot of flowers, the assays of which agree within the limits of experimental error. This is an important step forward.

A.—TRANSIT LOSSES

No special laboratory work was done on this subject. Preshipment samples and samples drawn in New York from 125th bale were assayed. No conclusions could be drawn from the results so work was stopped on the subject. In any case, since extract is to be the main item of export, the work became redundant.

B.—MOISTURE CONTENT OF PYRETHRUM

In 1952 a good deal of work had been done on the determination of moisture in pyrethrum and in the annual report for that year the subject was fully discussed. Further work has been done and the object of the investigation has been achieved, namely—the calibration of the Marconi Moisture Meter for use at places without laboratory facilities, where moisture determinations are needed to check growers' and export consignments.

Some interesting observations have accrued which may be of value in the field of other products. Some recapitulation is necessary to elucidate the subject. The methods of moisture determination used for pyrethrum and for most other products are as follows:—

(a) The time-honoured method of heating to constant weight in an oven at 105°C. This method suffers from various defects when dealing with a sensitive material such as pyrethrum. Not only is water driven off by the heating but also volatile substances such as essential oils, also the end point, "constant weight", is merely that point where decomposition losses are balanced by oxidation gains and may be well beyond the loss of "moisture and volatiles".

• (b) The empirical method, employed by us, namely, heating for five hours at the temperature of boiling water. These results were and are recorded as "moisture and volatile".

(c) Theoretically the ideal, storage *in vacuo* over a desiccant till there is no further loss in weight. Since heat is not applied, decomposition should not occur. Results by this method agree admirably with those by (b), possibly, it was thought, because in (b) all water had not been expelled.

(d) Distillation with a volatile solvent.

In this procedure the water separates from the solvent which returns to the flask leaving the water in a graduated tube where the volume can be read off. Any volatile oil remains in the solvent.

Normally a solvent lighter than water is used, such as toluene, and this, for most materials, is very suitable. With pyrethrum, however, the results are appreciably higher than by methods (b) and (c). This was found to be due to particles of powder sinking to the bottom of the flask when they were overheated, suffering decomposition with the production of water.

Recently an apparatus has been evolved which permits of the use of solvents heavier than water, such as carbon tetrachloride. In such a solvent the powder remains in suspension and so does not come in contact with the hot walls of the flask to suffer overheating and decomposition. One may accept moisture determinations by this apparatus as correct. Using a number of samples of varying water content a calibration curve has been drawn up for the Marconi Moisture Meter.

The results obtained with this apparatus were appreciably lower than by other methods. One could readily understand why they were lower than the oven methods but it was difficult to see why they were lower than the vacuum method. The matter was investigated, when it was found that the desiccant not only absorbed water but also the volatile essential oil which, incidentally, is water soluble. Recovery of the oil was difficult but the amount finally gained approximated to the difference.

It can now be accepted that we have a reliable method for the determination of moisture content and of the more generally used "moisture and volatile".

"Pyrethroids"

It has been proposed to create a new word—"pyrethroids", to designate those substances which, in chemical assays, appear as "pyrethrins" but which have no insecticidal properties.

A technique has been developed whereby some of the pyrethroids may be removed from a concentrated extract. It is, however, impossible to hazard any opinion as yet as to their character. This technique does not by any means remove all the pyrethroids; some, in certain cases, must pass through to the final purified concentrate. It would appear that the greater the proportion of pyrethroids the more rapidly does polymerization occur. On this basis a method for sifting selected clones and hybrids strains has been evolved; it must be appreciated that it has not yet been possible to confirm these adumbrations by means of bio-assays. However, some later work, to be discussed briefly below, appears to be confirmatory.

It has been found possible to fractionate polymerized, purified concentrates by means of various solvents. In normal concentrates the following fractions are obtained:—

- (i) A mobile liquid, highly toxic to insects and which assays at about 80 per cent "pyrethrins" and is very soluble in petroleum ether.
- (ii) A viscous liquid, toxic to insects, which assays at about 75 per cent "pyrethrins" and is slightly soluble in petroleum ether.
- (iii) A brittle glassy solid without effect on insects, assaying at about 65 per cent "pyrethrins", insoluble in petroleum ether and soluble in chloroform.

Until further work has been done, and this depends on the provision of more working space, one can only make conjectures about the nature of these three fractions. At present, it is convenient to regard them as, unpolymerized, partially polymerized and fully polymerized, but it is patent that the two latter contain constituents which are not "pyrethrins". Perhaps these polymerize more readily than the "pyrethrins".

In this connexion extracts from two strains were partitioned in the standard way. The purified concentrates polymerized very fast indeed, almost immediately. After standing a few weeks the material was fractionated. A fourth polymer was found—a crystalline solid—insoluble in petroleum and alcohol. It was not assayed but saponified direct. A white crystalline material separated which was identified as sodium carbonate. A new acid must be present. Conditions did not permit of a further study.

It is very evident that the pyrethrum plant is very labile. Its constituents can vary according to conditions and furthermore, the genes controlling the constituents appear to vary from plant to plant. The cross-bred strain illustrates the first point very well. In certain districts over 8,000 ft. the Py.I/Py.II ratio exceeds unity (1.72–1.11) but elsewhere, even at high altitudes, the ratio is less than unity, in one case being as low as 0.53. Incidentally, in English-grown flowers of the strain the ratio was as low as 0.4. The nature of the purified concentrates also varies. Those from flowers with a Py.I/Py.II ratio greater than unity polymerize slowly, those where the Py.I/Py.II ratio is less than unity polymerize fairly rapidly.

Acknowledgments

Finally the writer wishes to record his appreciation of the help and assistance accorded by his staff, past and present, European and African.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER-IN-CHARGE HIGH LEVEL SISAL RESEARCH STATION, THIKA, 1953

Meteorological

<i>Rainfall</i>	<i>Inches</i>	<i>Days</i>
January	0.62 ..	3
February	Nil	
March	2.45 ..	10
April	5.56 ..	9
May	3.89 ..	7
June	0.43 ..	3
July	0.42 ..	3
August	0.63 ..	5
September	0.35 ..	2
October	1.69 ..	6
November	4.47 ..	18
December	1.05 ..	9
TOTAL ..	21.56 ..	75

The average rainfall for the 13 years of recording at this station 1941 to 1953 is 32.68 in.

The long rains started late and the rainfall was well below average. The short rains were poor and finished early, consequently wilting of vegetation started in December, about one month earlier than usual.

There are at present 14 major trials in progress on the station and nine major trials on estates. Two herbicide trials are also in progress in collaboration with Messrs. Plant Protection Limited. The trials, which are controlled by the station, cover 1,110 plots with 22,926 individually recorded plants.

Two new external trials and one trial at the station were planted during the year. A new nursery trial was planted at the station and an old trial was planted with the third cycle of bulbils.

Investigational Work in Progress

A.—NURSERY TRIALS

A/3 Nursery Manurial and Mulching Trial

Object—To compare the effects of the fertilizers and sisal waste dug in as a mulch on the growth rate of bulbils in nurseries.

Date of commencement

First cycle planted 28th November, 1950, lifted one year and four months later.

Second cycle planted 15th April, 1952, lifted one year and seven months later.

Third cycle planted 24th November, 1953.

Spacing.—2 ft. x 9 in. (29,040 plants per acre).

Treatments

- N. 300 lb. sulphate of ammonia per acre.
- K. 120 lb. muriate of potash per acre.
- P. 180 lb. double superphosphate per acre.
- C. 30 tons well-rotted sisal waste dug in per acre.
- M. 30 tons well-rotted sisal waste mulched per acre.

Design.—2⁵ factorial confounded.

A comparison of the results obtained from the first and second cycles are given in the following tables:—

AVERAGE WEIGHT IN LBS. PER PLANT LIFTED

Main Factors	FIRST CYCLE		SECOND CYCLE	
	— Without	+ With	— Without	+ With
N	3.49	4.11	5.23	6.02
P	3.82	3.78	5.28	5.97
K	3.92	3.67	5.87	5.38
C	3.10	4.50	5.05	6.20
M	3.56	4.04	5.53	5.71

Differences needed for significance:—

P=0.05	0.35	0.56
P=0.01	0.49	0.78
P=0.001	0.69	1.09

Inter-actions	FIRST CYCLE						SECOND CYCLE					
	M		P		N		M		P		N	
	—	+	—	+	—	+	—	+	—	+	—	+
C—	3.00	3.66	3.07	3.59	3.21	3.44	4.51	5.58	4.81	5.28	4.65	5.45
C+	4.50	5.07	5.03	4.54	4.29	5.28	6.55	5.85	5.74	6.66	5.81	6.59

Differences needed for significance:—

P=0.05	0.50	0.79
P=0.01	0.70	1.10
P=0.001	0.98	1.54

From the table of main factors it will be noted that the application of sulphate of ammonia (N) has increased the size of the plants in both the first and second cycles ($P = 0.01$). There was no response to double superphosphate in the first cycle but in the second cycle there was a small response ($P = 0.05$). There was no significant response from muriate of potash in either cycle. The greatest response is obtained from sisal waste dug in (C) to the top layer of the soil before planting. The response has in both cycles, been highly significant ($P = 0.001$) and its use can be strongly advocated in bulbil nurseries. Waste dug in has been markedly

beneficial in both cycles; waste applied as a mulch has also been beneficial in both cycles, less so than the waste dug in the first cycle but having about the same effect as the latter in the second cycle. An application of 30 tons of sisal waste per acre which contains only 4 to 5 tons of dry matter may be inadequate to provide an effective cover. The table of interactions indicates that in the first cycle there was a marked response to N in the presence of C but not in the absence of C, whereas in the second cycle the response to N was about the same in the presence or absence of C and is barely significant in either case.

A/4 Nursery Nitrogen and Lime Trial

Object.—To ascertain the effect on soil and sisal plants of various nitrogenous fertilizers.

Date of commencement.—16th April, 1953.

Spacing.—2 ft. x 9 in. (29,040 plants per acre).

Treatments

Control.

Sulphate of ammonia 300 lb. per acre or 63 lb. N.

Nitrate of soda 394 lb. per acre or 63 lb. N.

Nitrate of lime 404 lb. per acre or 63 lb. N.

Agricultural lime 242 lb. per acre.

Sulphate of ammonia/agricultural lime as above.

Nitrate of soda/agricultural lime as above.

The lime levels were based on the calcium content of the nitrate of lime.

Design.—7 x 7 latin square.

The lime applications were made on the day of planting and the other fertilizer applications were made on 29th May, 1953 when the root systems were established.

The growth rate of the bulbils has been slow as the rainfall has been poor.

B.—PLANTING MATERIAL TRIALS

B/1 Planting Method Trial.

Object.—To compare yields when using graded old suckers from overgrown fields, graded young suckers from two-year-old fields and graded nursery plants produced from bulbils.

Date of commencement.—24th April, 1949.

Spacing.—12 ft. x 2 ft. 6 in. (1,452 plants per acre).

Treatments

Planting Material

Old suckers 19 in. high, weighing 6 lb.

Young suckers 15 in. high, weighing 1½ lb.

Nursery plants 18 in. high, weighing 4–5 lb.

Depth of Planting

Deep.—7 in. deep for young suckers; 9 in. deep for old suckers and nursery plants.

Shallow.—Approximately 3 in. deep for all three planting materials.

Design.—6 x 6 latin square.

The following table gives the leaf count and leaf length of the last unfurled leaf after recording in November, 1953:—

	LEAF COUNT			LEAF LENGTH IN INCHES		
	Shallow	Deep	Mean	Shallow	Deep	Mean
Nursery Plants ..	174.9	159.9	167.4	44.53	43.35	43.94
Young Suckers ..	171.4	161.5	166.5	42.09	42.48	42.28
Old Suckers ..	174.2	164.7	169.5	43.54	44.25	43.90
Mean	173.5	162.0		43.38	43.35	

In leaf count the difference between shallow and deep planted is highly significant ($P = 0.001$) while there is no significant difference between the three different planting materials.

In leaf length there is no difference between shallow and deep planted, and the leaf length of nursery plants and old suckers are only just significantly longer than that of young suckers ($P = 0.05$).

All the treatments had a second cut in January, 1953, and the yields to date are as follows:—

TONS OF UNBRUSHED LINE FIBRE PER ACRE AT 18TH JANUARY, 1953

				<i>Shallow</i>	<i>Deep</i>	<i>Mean</i>
Nursery plants	..	..	..	1.47	1.33	1.40
Young suckers	..	..	..	1.07	1.03	1.05
Old suckers	..	..	..	1.44	1.42	1.43
MEAN				1.33	1.26	

The difference between nursery plants and old suckers is not significant but both have so far produced more fibre than young suckers ($P = 0.001$). The difference in yields between shallow and deep planting is not significant.

B/2 Planting Material Trial

Object.—To investigate the possibility of obtaining greater efficiency by using larger nursery plants and to investigate the effect of an earlier first cut than is normal practice in Kenya.

Date of commencement.—3rd November, 1950.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments

Planting Material

Nursery plants 9 in. high, weight about 1 lb.

Nursery plants 15 in. high, weight 3–3½ lb.

Nursery plants 21 in. high, weight 6½–7 lb.

Age at First Cut

Early.—80–90 leaves produced since planting.

Normal.—100–110 leaves produced since planting.

Late.—120–130 leaves produced since planting.

Intensity of Cut

Heavy.—Leaving 25 leaves after 1st cut and 20 leaves after subsequent cuts.

Medium.—Leaving 35 leaves after 1st cut and 30 leaves after each subsequent cut.

Light.—Leaving 45 leaves after 1st cut and 40 leaves after each subsequent cut.

Design.—3³ factorial confounded. Two replications.

The most recent recording indicates that the 9 in. and 15 in. plants have produced a similar number of leaves of approximately the same length, but the biggest planting material has produced more leaves of greater length than the smaller planting material.

Early cutting has not affected the rate of leaf production but it has had the effect of retarding the increase in leaf length. This check may of course be only temporary. The following table gives the leaf length:—

	NUMBER OF LEAVES PRODUCED AT TIME OF 1ST CUT		
	80-90 Leaves	100-110 Leaves	120-130 Leaves
	(1)	(2)	(3)
	<i>in.</i>	<i>in.</i>	<i>in.</i>
Leaf Length at Time of Planting	13.74	13.86	13.70
Leaf Length at 2 years	36.42	36.53	37.01
Leaf Length at 2½ years	1st cut 2 years 39.84	41.14	41.93
Leaf Length at 3 years	41.85	1st cut at 2½ years 43.98	45.59

NOTE.—It will be noted that the leaf lengths in the three columns are almost identical up to the age of two years. It will also be noted how column (1) lags behind the other two, after it has had an early first cut. After column (2) has had a first cut it also lags behind column (3).

Yields of fibre obtained from the first cut are as follows:—

<i>Size of Planting Material</i>					<i>Tons Fibre Per Acre</i>
<i>Inches</i>					
9	..	..	..	..	0.39
15	..	..	..	..	0.40
21	..	..	..	..	0.65
<i>First Cut at</i>					
80-90 leaf stage	..	..	..	..	0.16
100-110 leaf stage	..	..	..	..	0.52
120-130 leaf stage	..	..	..	..	0.76

A greater number and weight of leaves has been cut from the big planting material with a corresponding higher yield of fibre. The proportion of short leaves to long leaves was also considerably smaller in the biggest planting material.

B/3 Bulbils, Nursery Plants and Suckers Trial

Object.—To compare bulbils planted *in situ* in the field with nursery plants and suckers, and further to compare flat and ridged planting on red soils.

Date of commencement.—7th November, 1950.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments

Bulbils, average weight 3 oz., planted *in situ* in fields.

Nursery plants, 15 in. high, weight 3–3½ lb.

Suckers from old areas, 25 in. high weighing 10–12 lb.

Ridged v. flat.

Design.—6 x 6 latin square.

The unevenness in the bulbil plots in this trial, mentioned in last year's report, is still evident and the plants are a good deal smaller than either nursery plants or suckers.

The results obtained so far emphasize the fact that big planting material grows faster and reaches a given size faster than small planting material.

B/4 Grading of Planting Material Trial

Object.—To investigate which factor or factors mostly influence the evenness of growth in height of plants in sisal fields.

Date of commencement.—17th April, 1952.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments

Height.—When transplanting from nursery to field 18 in. from ground level to tip of central spike.

Girth.—11½ cm. in diameter at base of plant.

Weight.—Ranging from 5 lb. 10 oz. to 6 lb. 6 oz.

Design.—2³ partially confounded, which covers all the possible combinations of the three treatments, including a control plot with plants taken at random from the nursery without any attempt at selection.

To assess the variations, the coefficient of variance was calculated on plant height, which was taken from ground level to tip of central spike.

It is obvious in the field that the ungraded plants are more uneven than the graded plants. The results so far indicate that grading for weight and height have produced the most even stand.

B/5 Cured Planting Material Trial

Object.—To investigate the effect on nursery plants of a curing process for varying lengths of time before planting out in the field.

Date of Planting

Before long rains, 18th April, 1953.

Before short rains, 15th November, 1953.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments.—Curing in the sun and under cover for three, two and one months before planting in the long and short rains v. the planting of fresh material.

Design.—Randomized blocks, two replications.

This trial is in the nature of a look-see trial and should give an indication of the difference between curing during the hot, dry season before the long rains, and curing in the cloudy weather before the short rains.

It is too early to comment on this trial, but it can be said that all the material planted in April, 1953, has started to grow without trouble.

D.—PLANT MANAGEMENT TRIALS

The object of the following five external trials D/3–D/7 is to ascertain variations in growth rates in the various districts of Kenya using different spacing and cutting treatments.

Treatments for all the five trials are as follows:—

Spacing

- 11 ft. between single rows.
- 14 ft. between single rows.
- 18 ft. x 3 ft. double row planting.

Populations

- 1,200 plants per acre.
- 1,600 plants per acre.
- 2,000 plants per acre.

Development at First Cut

- 100 leaves grown since planting.
- 125 leaves grown since planting.
- 150 leaves grown since planting.

Severity of Cutting

- Light.—Leaving 30 leaves after each cut.
- Medium.—Leaving 20 leaves after each cut.
- Heavy.—Leaving 10 leaves after each cut.

Design—3⁴ factorial arranged as a 9 x 9 *quasi latin square*.

D/3 Ruiru Trial (Black Cotton Soil) Ridged

Locality.—Juja Farm, Ruiru.

Date of commencement.—16th March, 1948.

SUMMARY OF RESULTS UP TO 1ST OCTOBER, 1953

SPACING	AVERAGE NO. OF LEAVES GROWN PER PLANT				LEAF LENGTH IN INCHES FOR THE LAST UNFURLED LEAF			
	Spacing between Rows			Mean	Spacing between Rows			Mean
	14'	11'	18' x 3'		14'	11'	18' x 3'	
Population								
1,200	159.94	165.88	169.43	165.08	45.2	44.1	45.6	45.0
1,600	137.76	143.07	143.29	141.37	42.3	41.3	42.4	42.0
2,000	127.67	135.87	135.62	133.05	41.6	42.4	42.4	42.2
Mean ..	141.79	148.28	149.44	146.50	43.0	42.6	43.5	43.1

Least significant differences between two means:—

			<i>Leaf Count</i>	<i>Leaf Length</i>
P = 0.05	..	..	8.25	2.67
P = 0.01	..	..	11.11	3.60

Least significant differences between two 2-factor interactions (i.e. figures shown in the body of the tables):—

			<i>Leaf Count</i>	<i>Leaf Length</i>
P = 0.05	..	..	14.29	4.63
P = 0.01	..	..	19.24	6.23

This trial continues to be the most uneven of all the trials in progress. The Soil Physicist of the East African Agricultural and Forestry Research Organization has examined soil samples from the good and poor areas and he has found that the total pore space as a percentage of total soil volume is about 32 per cent for the good samples and about 23 per cent for the poor samples. As a comparison the total pore space for subsoil in the Kikuyu red loam is over 50 per cent. Hence, where the pore space is as critically low as 32 per cent a further reduction of 10 per cent may be expected to cripple the crop. These findings substantiate those of the Soil Chemist, which were published in the 1952 report.

Poling in some of the plots with the lowest population necessitated a pole cut in August, 1953, but the overall growth was so slow that the latest first cut still remains to be taken.

D/4 Trans Nzoia Trial

Locality.—Ziwa Limited, Hoey's Bridge.

Date of commencement.—10th April, 1948.

This trial has grown well and evenly, but the rate of leaf production and length are somewhat lower than those of sisal growing in trials at lower altitudes.

Plots in the two earlier first cut treatments have had three cuts, whereas those which had the latest first cut have had two cuts. The results to date are given in the table below:—

	Total Leaf Count	Length of Last Leaf Grown	No. of Leaves Cut per Plant	Weight in lb. of Leaves Cut per Plant	Weight in Tons of Unbrushed Fibre per Acre	Fibre %
EFFECTS OF ROW SPACING:—						
14 ft.	188.1	44.3	102.5	130.6	2.28	2.50
11 ft.	197.7	44.3	109.5	148.4	2.64	2.55
18 ft. x 3 ft. ..	190.4	44.1	102.6	132.7	2.38	2.54
POPULATION PER ACRE:—						
1,200	206.5	44.9	119.0	166.2	2.34	2.59
1,600	191.3	44.3	104.8	135.8	2.52	2.54
2,000	178.3	43.4	91.0	107.5	2.44	2.44
EARLINESS OF 1ST CUT AT:—						
110 leaves	190.9	41.6	108.0	127.2	2.44	2.73
135 leaves	190.6	43.9	104.3	134.5	2.32	2.44
160 leaves	194.6	47.2	102.3	148.0	2.53	2.41
SEVERITY OF CUTS:—						
Leaving 30 leaves ..	192.6	45.6	91.6	116.3	1.90	2.39
Leaving 20 leaves ..	193.0	44.5	106.3	141.3	2.51	2.54
Leaving 10 leaves ..	190.5	42.4	116.9	152.0	2.82	2.65
DIFFERENCE NEEDED FOR SIGNIFICANCE:—						
P=0.05	2.7	0.9	3.5	8.5	0.19	0.06
P=0.01	3.6	1.2	4.8	11.4	0.26	0.08

Effect of Row Spacing

When the two single row spacings of 14 ft. and 11 ft. are compared it will be noted that the latter is better than the former in every respect, a fact which can only be attributed to the greater distance between plants in the rows. It is thus clear that the distance between rows should be reduced to a minimum, consistent with the use of implements for inter-row cultivation. This will enable plants to be more widely spaced in the rows.

Effect of Population

It will be noted that although the higher populations have produced fewer leaves per plant, the yield of fibre per acre is the same for all populations. It will also be noted that the length of the 208th leaf in the lowest population is only slightly longer than the 178th leaf of the highest population, and the records show that the 178th leaf of the lowest population was no longer than the same leaf in the highest population. One is, therefore, led to believe that leaf length is dependent on soil fertility and climate to a much larger extent than the number of plants per acre, when using the range of populations included in these trials.

Effect of First Cut at Various Stages of Development

The early first cuts have had the effect of producing leaves which are shorter and lighter, but with a higher percentage of fibre. The yield of fibre per acre shows no significant differences between treatments.

Effect of Severity of Cutting

The effect, which can be noticed at present, is that heavy cutting reduces leaf length, especially when the first cut is taken early. The effect on yield cannot be assessed until the end of the cycle.

D/5 Kampi-ya-Moto Trial

Locality.—Alphega Estate, Kampi-ya-Moto.

Date of commencement.—23rd October, 1948.

The stand of sisal in this trial is not as regular as could be desired. This can be attributed to poor and rather uneven soil in the trial area.

All the plots have now been cut and the results to date are given in the following table:—

	Total Leaf Count	Length of Last Leaf Grown	No. of Leaves Cut per Plant	Weight in lb. of Leaves Cut per Plant	Weight in Tons of Unbrushed Fibre per Acre	Fibre %
EFFECTS OF ROW SPACING:—						
14 ft.	147.6	44.6	62.38	68.41	1.16	2.40
11 ft.	156.0	45.0	69.93	82.38	1.43	2.49
18 ft. x 3 ft.	138.5	42.3	54.19	50.09	0.84	2.37
EFFECT OF POPULATION:—						
1,200	159.4	44.6	72.33	86.09	1.17	2.44
1,600	148.1	44.9	63.74	67.65	1.21	2.41
2,000	134.5	42.4	50.42	47.15	1.06	2.37
EARLINESS OF 1ST CUT AT:—						
100 leaves	146.5	42.0	73.63	74.10	1.32	2.50
125 leaves	149.2	45.7	57.33	61.84	1.00	2.32
150 leaves	146.4	44.2	55.55	64.95	1.10	2.41
SEVERITY OF CUTS:—						
Leaving 30 leaves ..	147.6	43.7	51.81	52.01	0.85	2.36
Leaving 20 leaves ..	145.9	44.4	60.74	64.10	1.11	2.43
Leaving 10 leaves ..	148.5	43.8	73.94	84.76	1.47	2.44
DIFFERENCE NEEDED FOR SIGNIFICANCE:—						
P=0.05	11.09	2.25	3.57	3.24	0.20	0.05
P=0.01	14.93	3.03	4.81	4.37	0.27	0.07

This sisal has grown faster than that at Ruiru and Trans Nzoia but it has been slower than the sisal at Thika and Kibwezi. It would be unwise to draw conclusions from this trial until further cuts have been taken, but it would appear that on such poor land the maximum population should be about 1,600 plants per acre.

D/6 Thika Trial (Red Soil)

Locality.—Anglo-French Sisal Estate, Thika.

Date of commencement.—17th November, 1948.

This trial has grown very well although it is planted on land which has been under sisal for a considerable number of years. All the plots have now been cut and yield figures up to April, 1953 (at 4½ years) are given below:—

	Total Leaf Count	Length of Last Leaf Grown	No. of Leaves Cut per Plant	Weight in lb. of Leaves Cut per Plant	Weight in Tons of Unbrushed Fibre per Acre	Fibre %
EFFECTS OF ROW SPACING:—		<i>in.</i>				
14 ft.	147.7	47.9	76.4	97.6	1.74	2.56
11 ft.	160.5	48.6	86.9	118.0	2.16	2.59
18 ft. x 3 ft.	148.7	47.2	72.5	89.2	1.60	2.53
EFFECT OF POPULATION:—						
1,200	166.1	48.3	88.5	126.0	1.76	2.57
1,600	150.7	47.7	78.0	97.0	1.79	2.55
2,000	140.1	47.9	69.2	81.8	1.95	2.56
EARLINESS OF CUTS AT:—						
100 leaves	152.9	43.7	87.7	98.8	1.85	2.60
125 leaves	152.4	48.6	86.5	111.5	1.94	2.46
150 leaves	151.5	51.4	61.6	94.3	1.72	2.62
SEVERITY OF CUTS:—						
Leaving 30 leaves ..	153.5	48.7	68.3	87.4	1.50	2.49
Leaving 20 leaves ..	149.8	46.9	75.4	93.6	1.67	2.57
Leaving 10 leaves ..	153.6	48.3	92.1	123.7	2.33	2.63
DIFFERENCE NEEDED FOR SIGNIFICANCE:—						
P=0.05	2.21	1.30	2.79	13.12	0.19	0.04
P=0.01	2.98	1.50	3.76	17.67	0.26	0.05

It will be noted that row spacing, population and severity of cutting have so far had little or no effect on leaf length, but an early first cut has retarded the increase in leaf length. It must be remembered that one of the objects of an early first cut is to give the plants a check in order to retard poling and thus prolong the period during which they will produce leaves of a commercial length. As these trials progress it will be very interesting to see how the different cutting treatments influence the final yield of fibre per acre and also the number of leaves required to produce a ton of fibre.

D/7 Kibwezi Trial

Locality.—Dwa Plantations Limited, Kibwezi.

Date of commencement.—21st October, 1949.

In spite of the erratic rainfall under which this trial has grown it made more rapid growth during the first $2\frac{1}{2}$ years than any of the other external trials. This was especially noticeable in leaf length. The rate of growth was slowed down during 1953 by the very dry weather.

The trial was last recorded for leaf count and leaf length in December, 1953, and a summary of results is given in the following table:—

SPACING	AVERAGE NO. OF LEAVES GROWN PER PLANT				LEAF LENGTH IN INCHES FOR THE LAST UNFURLED LEAF			
	Space between Rows			Mean	Space between Rows			Mean
	14'	11'	18' x 3'		14'	11'	18' x 3'	
Population								
1,200	149.7	157.2	147.7	151.5	54.6	53.9	53.8	54.1
1,600	134.4	144.7	132.9	137.3	55.0	54.5	52.5	54.0
2,000	118.4	132.7	124.8	125.3	52.4	54.4	53.4	53.4
Mean ..	134.2	144.9	135.1	138.0	54.0	54.3	53.2	53.8

Least significant difference between two means:—

	Leaf Count			Leaf Length	
P = 0.05	3.05			1.18	
P = 0.01	4.11			1.59	

Least significant difference between two 2-factor interactions:—

	Leaf Count			Leaf Length	
P = 0.05	5.29			2.04	
P = 0.01	7.12			2.75	

Yield figures cannot be given until the last 27 plots get a first cut in 1954. It can, however, be said that the highest population of 2,000 plants per acre has not reduced leaf length to any appreciable extent

D/8 Double v. Single Row Trial

Object.—To compare various plant populations and row spacings, and to establish whether a certain plant population will perform equally well whether planted in single row or double rows, when the distance between rows is the same.

Date of commencement.—15th April, 1952.

Treatments (Populations)

1,600 plants per acre.

2,000 plants per acre.

2,400 plants per acre.

Distance between rows.—11 ft.; 13 ft.

Row spacing.—Double rows 3ft. between rows; single rows.

These treatments cover the following range:—

<i>Single Row</i>	<i>Double Row</i>	<i>Populations per acre</i>
11 ft. x 2 ft. 6 in.	11 ft. x 3 ft. x 4 ft.	1,600
11 ft. x 2 ft.	11 ft. x 3 ft. x 3 ft.	2,000
11 ft. x 1 ft. 8 in.	11 ft. x 3 ft. x 2 ft. 6 in.	2,400
13 ft. x 2 ft.	13 ft. x 3 ft. x 3 ft. 6 in.	1,600
13 ft. x 1 ft. 9 in.	13 ft. x 3 ft. x 2 ft. 9 in.	2,000
13 ft. x 1 ft. 5 in.	13 ft. x 3 ft. x 2 ft. 3 in.	2,400

Design.—3 x 2 x 2 partially confounded.

The last recording of this trial took place in October, 1953, at 1½ years after planting, with the following results:—

PLANTS PER ACRE	LEAF COUNT					LEAF LENGTH IN INCHES				
	Double Row		Single Row			Double Row		Single Row		
	11 ft.	13 ft.	11 ft.	13 ft.	Mean	11 ft.	13 ft.	11 ft.	13 ft.	Mean
1,600 ..	56.2	56.8	57.0	53.4	55.9	11.92	12.13	12.32	11.65	12.00
2,000 ..	55.1	52.8	51.6	52.2	52.9	12.48	11.38	11.46	12.08	11.85
2,400 ..	54.6	53.0	51.2	46.3	51.3	11.85	11.61	11.97	11.97	11.85
Mean ..	55.3	54.2	53.3	50.6		12.09	11.69	11.93	11.89	
Mean ..	54.7		51.9			11.89		11.89		

It is still too early to draw any definite conclusions but, so far, the double-row spacing has produced a few more leaves than the single-row spacing and the leaf length is the same for both spacings.

E.—CULTIVATION TRIALS

E/1 Cultivation Trial

Object.—To investigate the effect on the soil and sisal plants of continuous clean weeding by mechanical means as against restricted weeding with and without a controlled grass cover in the area between sisal lines.

Date of commencement.—1st November, 1950.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments

- (1) Grass strip slashed frequently to keep grass low.
- (2) Grass strip cut periodically and the cut grass used as mulch around sisal plants.
- (3) Clean weeded by frequent discing for the first three years, then as (1).
- (4) Clean weeded by frequent discing for the first three years, then discing twice a year.
- (5) Discing twice a year for the whole cycle.
- (6) Clean weeding by frequent discing for the whole cycle.

This trial incorporates the above treatments with sisal planted on the flat and on ridges. The grass cover is obtained by sowing Rhodes grass (*Chloris gayana*) in six feet wide strips between the double rows.

Design.—Rectangular lattice square with four replications.

The trial was cut for the first time in June, 1953, two years eight months after planting when the number of leaves produced per plant averaged 110 with the last unfurled leaf 46 in. in length. The variations in yield are very small and so far none can be attributed to any treatment.

The average yield for the first cut is 0.84 tons of unbrushed fibre per acre. This is an outstandingly good yield and demonstrates the advantage of having a high level of fertility in sisal growing areas.

F.—FERTILIZER TRIALS

F/1 Fertilizer Trial

Object.—To investigate the effect on the growth rate of sisal plants by applying artificial fertilizers and/or sisal waste.

Date of commencement.—16th March, 1950.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments

- (1) Sulphate of ammonia (N) applied at the rate of 388 pounds per acre in each of the first four years of the cycle.
- (2) Double superphosphate (P), applied in shallow trenches under the plants a week before planting at the rate of 260 pounds per acre.
- (3) Muriate of potash (K), applied at the rate of 395 pounds per acre for the first year and 300 pounds per acre during each of next three years.
- (4) Agricultural lime (Ca) (96 per cent Ca CO_3), broadcast over the whole treated area at the rate of 2 tons per acre a month before planting.
- (5) Sisal waste (W) as fresh sisal waste taken straight from a Corona decorticator, decorticating dry. The waste was applied at the rate of 107 tons wet waste per acre and dug in one month before planting in strips covering an area four feet each side of the double rows.

Design.—2⁵ factorial.

The individual plots in this trial were given a first cut when the number of leaves produced since planting reached an average of between 110–120. Each of the five main factors in this trial is represented in 16 plots. The following table gives the number of plots and the dates on which they were cut:—

	23/9/52 (2 years 6 months)	26/1/53 (2 years 10½ months)	1/6/53 (3 years 2½ months)
W	11 plots	5 plots	—
P	9 plots	5 plots	2 plots
N	8 plots	6 plots	2 plots
Ca	6 plots	8 plots	2 plots
K	6 plots	6 plots	4 plots

The above table gives an indication of the stimulus which waste gave to the initial growth of the sisal.

The effects of the five treatments on leaf count and leaf length, based on a recording in October, 1953, are given below:—

Leaf Count	Average Leaf Count of Plants Without	Average Leaf Count of Plants With	Mean Effects
Ca	137.14	141.13	3.99 (P=0.05)
W	131.54	146.73	15.19 (P=0.001)
N	135.84	142.43	6.59 (P=0.01)
P	136.58	141.69	5.11 (P=0.01)
K	140.28	137.99	-2.29 Not Significant (N/S)

Leaf Length in Inches	Average Leaf Length of Plants Without	Average Leaf Length of Plants With	Mean Effects
	<i>In.</i>	<i>In.</i>	<i>In.</i>
Ca	40.92	42.99	2.07 (P=0.001)
W	40.04	43.86	3.82 (P=0.001)
N	41.56	42.34	0.78 N/S
P	41.28	42.63	1.35 (P=0.05)
K	42.13	41.78	-0.35 N/S

The quarterly recordings give an indication of the residual effects of the various fertilizers and they are providing a guide for future fertilizer trials.

The agricultural lime has effected a small but steady increase in both the number and length of leaves produced.

The application of sisal waste has improved the growth of sisal to a greater extent than any of the other fertilizers. It exerted its greatest influence during the first 2½ years of the cycle when it had produced a leaf length of 41 in. which was 5 in. longer than plants which had not been treated with sisal waste.

Sulphate of ammonia, which has been applied in annual dressings, has effected a steady increase in the number of leaves grown, but it has had little effect on leaf length.

Double superphosphates provided an initial stimulus to growth which lasted for about 1½ years for rate of leaf production and 2½ years for leaf length.

The effect of muriate of potash has been negligible and not significant.

Yield figures will be published when all the plots are cut at the same time during 1954.

F/2 Sisal Waste and Minerals Trial

Object.—To compare the effect of different methods of applying fresh sisal waste, sisal waste reinforced with artificial fertilizers and artificial fertilizers alone.

Date of commencement.—17th March, 1950.

Treatments

	Fresh Sisal Waste	Sulphate of Am- monia	Double Super Phos- phate	Muriate of Potash	Agric. Lime (Ca CO ₃ 96%)
	<i>Tons</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>Tons</i>
A Control	Nil	Nil	Nil	Nil	Nil
B Waste half dug in and half as mulch	107	Nil	Nil	Nil	Nil
C Waste all dug in	107	Nil	Nil	Nil	Nil
D Waste all as mulch	107	Nil	Nil	Nil	Nil
E Waste half dug in and half as mulch with minerals added	107	390	65	325	0.42
F Waste all dug in with minerals added	107	390	65	325	0.42
G Waste all as mulch with minerals added	107	390	65	325	0.42
H Minerals only	Nil	1,560	260	1,300	2.0

(1) The waste, lime and superphosphate were applied before planting as in the fertilizer trial. Sulphate of ammonia applied with waste at the rate of 129 lb. per acre for first year and 87 lb. per acre during each of the next three years. Applied without waste at the rate of 522 lb. for the first year and 346 lb. per acre during each of the next three years.

(2) Muriate of potash applied with waste at the rate of 130 lb. per acre the first year and 65 lb. during each of the next three years. Applied without waste at the rate of 520 lb. per acre for the first year and 260 lb. during each of the next three years.

Design.—Four randomized blocks of eight plots.

The following results are obtained from the figures for the last recording in October, 1953:—

	A	B	C	D	E	F	G	H	P=.05	P=.01
Leaf Count	131.3	143.2	141.6	145.4	149.9	150.0	147.7	145.2	2.59	3.53
Leaf Length in Inches	42.05	41.75	42.27	43.34	47.12	45.10	44.24	43.17	3.17	4.32

All treatments have produced a significantly greater number of leaves than the control but there is little difference between the treatment responses.

Each plot in this trial was cut when the plants had produced an average of 110–120 leaves since planting. Consequently the yield differences for the first cut are not great. It is of interest to note that all plots receiving fertilizer treatments were cut within a period of four months, whereas the four control plots were cut over a period of nine months which indicates a more even growth in the treated plots.

F/3 Rotational Fertilizer Trial

Object.—To investigate the effect on sisal of resting the land under grass for a period of years between the cycles with and without a grass cover during the cycle. These treatments are combined with fertilizer treatments on bare land and grass strips between the sisal rows.

Locality.—Anglo-French Sisal Estate, Thika.

Date of commencement.—24th November, 1952.

Treatments

First Cycle	Second Cycle
(1) Clean weed by frequent discing throughout.	As first cycle.
(2) Plant grass strips, cut grass and mulch along sisal rows.	As first cycle (sisal replanted where grass strips were).
(3) Plant grass strips, cut grass and mulch along sisal rows.	Leave grass strips to cover land for three years then replant sisal and treat as first cycle.
(4) Clean weed by frequent discing throughout.	Three years grass ley then as first cycle.

Superimposed on the above treatments are the following fertilizer treatments:—

Control, N, P, Ca, NP, NCa, PCa and NPCa.

Sulphate of ammonia (N).—200 lb. per acre for the first four years of the cycle.

Double superphosphate (P).—150 lb. per acre at planting.

Agricultural lime (Ca).—Two tons per acre just before planting.

Design.—Six randomized blocks of four plots each. Each plot split for N, P and Ca (24 plots or 96 split plots).

Planting.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

The trial has grown well in spite of the low rainfall. The cultivation treatments so far have had no effect and, the only fertilizer which seems to have stimulated growth to a slight extent is double superphosphate.

Small patches of couch (*Digitaria scalarum*) have been sprayed with success with TCA at the rate of 20 lb. per acre.

F/4 Fertilizer, Waste and Grass Trial

Object.—To investigate the effect of N, P, Ca, and sisal waste on old sisal land with and without grass strips introduced between the sisal lines.

Locality.—Anglo-French Sisal Estate, Thika.

Date of commencement.—3rd December, 1952.

Treatments.—The following applications were applied singly and in all possible combinations:—

Sisal waste.—Collected from a rotary pulp extractor and applied at the rate of 20 tons per acre in 6-ft. strips covering the planting lines.

Sulphate of ammonia (N).—200 lb. per acre applied close to the plants in April, 1953.

Double superphosphate (P).—150 lb. per acre applied as 108 lb. per acre at planting by dropping $7/8$ th oz. under each plant. The balance applied in the centre of the wide space between the double rows in April, 1953.

Agricultural lime (Ca).—At the rate of two tons per acre applied broadcast on 1st December, 1952.

Grass.—Molasses grass (*Melinis minutiflora*) planted as strips between the sisal rows in April, 1953.

Planting.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Design.—2^s factorial confounded.

The only treatment which has had any effect during the first year of growth is sisal waste, which has increased both the number and length of leaves significantly.

F/5 Exploratory Fertilizer Trial, Dwa

Object.—To investigate the effect of sisal waste, double superphosphate, sulphate of ammonia and agricultural lime on a soil which has been under sisal for a lengthy period in the Kibwezi area.

Locality.—Dwa Plantations Ltd., Kibwezi.

Date of commencement.—18th April, 1953.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments

Sisal waste at rates of 25, 50 and 100 tons per acre.

Double superphosphate at rates of—

150 lb. per acre at planting.

150 lb. per acre at planting plus one repetition.

150 lb. per acre at planting plus three repetitions during the cycle.

Agricultural lime.—Two tons per acre.

The plots are split for an application of sulphate of ammonia.

Design.—2^s factorial confounded.

The trial area was first planted with sisal in 1919 and since then it has carried an unrestricted sucker growth until it was cleared in 1952. It has, however, produced only about $5\frac{1}{2}$ tons of fibre during the whole period. There are no results so far to report.

F/6 Exploratory Fertilizer Trial, Zea

Object.—To investigate the effect of sisal waste, double superphosphate, sulphate of ammonia and agricultural lime on old sisal land in the Kitale area where symptoms of deficiency diseases have been noticed on sisal.

Locality.—Zea Estate Ltd., Kitale.

Date of commencement.—9th July, 1953.

Spacing.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

Treatments

Sisal waste at rates of 25, 50 and 100 tons per acre.

Double superphosphate at the rate of—

150 lb. per acre at planting.

150 lb. per acre at planting plus one repetition.

150 lb. per acre at planting plus three repetitions during the cycle.

Agricultural lime.—Two tons per acre.

The plots are split for an application of sulphate of ammonia.

Design.—2⁵ factorial confounded.

The area which was infested with couch was sprayed two days before planting with TCA at the rate of 30 lb. per acre.

Results are not yet available.

F/9 Poor land Fertilizer Trial

Object.—To attempt to rehabilitate some very poor sisal, three years old, growing on exhausted and eroded land.

Locality.—High Level Sisal Research Station, Thika.

Date of commencement.—Sisal originally planted in March, 1950.

Treatments

Sisal waste.—50 tons after long rains, 1953; 50 tons before long rains, 1954; 50 tons before long rains, 1954, and removing lower leaves.

Agriculture lime.—Two tons per acre applied, June, 1953.

Sulphate of ammonia.—300 lb. per acre before long rains, 1954.

Double superphosphates.—150 lb. per acre before long rains, 1954.

The effects of fertilizers are at present too small to warrant comment.

H.—PRODUCTION OF IMPROVED PLANTING MATERIAL TRIALS

H/1 Hybrid Variety Trial

Object.—To observe and compare the performance of common sisal with eight promising hybrids received from Mlingano Experimental Station, Ngomeni, Tanganyika Territory.

Date of commencement.—7th April, 1952.

Treatments.—Hybrids Nos. 1155, 1269, 1300, 1317, 1475, 1660, 6964, 7131, all obtained from Mlingano Experimental Station, Ngomeni, Tanganyika Territory; and common sisal (*Agave sisalana*).

Design.—3 x 3 balanced lattice. Nine treatments and four replications.

Planting.—13 ft. x 3 ft. x 2 ft. 9 in.

The hybrids have produced 61 to 97 new leaves during the 1½ years growth, whereas the common sisal has produced 52.5 leaves in the same time. On the other hand the leaves produced by the hybrids are shorter, varying from 15.75 in. to 22.4 in., whilst the common sisal has reached a leaf length of 24 in.

H/2 Plant Selection Trial

Object.—To compare common sisal (*Agave sisalana*) with progeny of what has in some cases wrongly been termed non-flowering sisal.

Date of commencement.—20th April, 1952.

Treatments

From a so-called non-flowering plant No. 2 (Carver ex Juja) three suckers were collected. When they poled, bulbils were collected and the subsequent nursery plants are here marked A, B and C.

Suckers from a non-flowering plant No. 1 (Everard ex Donyo Sabouk) were planted and marked D.

The common sisal is marked E.

Design.—Six randomized blocks of five treatments.

Planting.—13 ft. x 3 ft. x 2 ft. 9 in. (1,980 plants per acre).

The number of leaves produced by the selections since planting vary from 100–114 against 53 leaves produced by common sisal. The leaves of common sisal have, however, reached a length of 32.25 in. against the selections which vary from 20 in. to 26 in. The size of planting material used in this trial was considerably bigger than that used in H/1 which was planted at the same time, hence the greater length of leaf.

Little can be said about the plant selection trials until they have been cut and the yields and fibre characteristics have been compared.

J.—HERBICIDE TRIALS

J/2 Couch Trial 2

Object.—To ascertain whether and to what extent couch (*Digitaria scalarum*) can be controlled by applications of Iso-propyl phenyl carbomate (IPPC) and sodium trichloroacetate (TCA).

Co-operator.—Messrs. Plant Protection Limited.

Date of commencement.—Herbicides applied 1st May, 1951; sisal planted 15th May, 1951.

Treatments

After one ploughing and harrowing before the couch emerged.

Control—

10 lb. TCA with 80 gallons of water per acre.

20 lb. TCA with 80 gallons of water per acre.

40 lb. TCA with 80 gallons of water per acre.

100 lb. IPPC dust per acre.

300 lb. IPPC dust per acre.

Design.—Randomized blocks, four replications.

Couch Control

10 lb. TCA/acre gave a good control of couch grass for three months and after 12 months there was a 50 per cent cover of couch and an almost complete infestation was observed 24 months after spraying.

20 lb. TCA/acre has given a complete control of couch grass for a period of six to eight months and even after 24 months reinfestation gave only a 50 per cent cover of soil.

40 lb. TCA/acre has given a complete control of couch grass for a period of 10 to 12 months, and after 24 months the plots were relatively free of couch.

Observations made in August 1953, 27 months after spraying, showed that reinfestation of couch grass was competing with the sisal causing a yellowing of leaf on most of the treated plots—10-lb. plots showed more marked yellowing than the 20- and 40-lb. plots.

SUMMARY OF GRADINGS FOR "COUCH" COVER
(0=No "Couch"; 10=Complete "Couch" Cover)

TIME AFTER SPRAYING	LB. TCA/ACRE				LB. IPPC 5% DUST	
	0	10	20	40	100	300
4 months ..	3.3	0.8	0.0	0.0	3.3	4.0
6 months ..	5.3	1.5	0.4	0.1	5.8	6.0
10 months ..	8.5	4.3	2.3	1.5	7.3	9.0
12 months ..	9.3	5.5	2.5	1.8	8.8	9.5
27 months ..	10.0	8.0	6.0	4.0	10.0	10.0

AVERAGE NUMBER OF LEAVES PRODUCED PER PLANT

TIME AFTER SPRAYING	LB. TCA/ACRE				LB. IPPC 5% DUST	
	0	10	20	40	100	300
10 months ..	8.2	15.2	17.5	18.5	8.3	9.2
12 months ..	13.8	23.4	26.1	27.6	13.8	14.6
18 months ..	25.3	39.4	43.0	46.2	24.9	25.7
21 months ..	30.4	46.5	51.2	54.8	30.0	31.2
24 months ..	35.6	53.3	58.8	63.1	35.8	36.9
27 months ..	39.6	57.3	64.0	68.4	39.1	41.6

AVERAGE LENGTHS OF LEAVES PER PLANT

TIME AFTER SPRAYING	LB. TCA/ACRE				LB. IPPC 5% DUST	
	0	10	20	40	100	300
10 months ..	43.5	49.8	49.8	50.2	43.3	44.6
12 months ..	45.3	54.3	53.5	54.9	46.2	46.3
18 months ..	51.0	61.4	63.6	65.3	52.2	51.9
21 months ..	52.3	65.1	67.1	70.9	53.7	54.8
24 months ..	54.8	70.0	72.3	76.8	55.7	56.8
27 months ..	65.9	71.4	75.2	78.8	57.4	59.5

J/4 Couch Trial No. 4

Object.—To compare the effect of various applications of TCA with various rates of water.

Co-operator.—Messrs Plant Protection Limited.

Date of commencement.—Herbicide applied 16th May, 1952; sisal planted 21st May, 1952.

Treatments

All treatments applied pre-emergent of couch with knapsack sprayer.

10 lb. TCA in 20 gallons spray per acre.

10 lb. TCA in 80 gallons spray per acre.

30 lb. TCA in 20 gallons spray per acre.

30 lb. TCA in 80 gallons spray per acre.

Design.—5 x 5 latin square.

The following observations can be made on this trial:—

Control of Couch

Seven months after spraying, the 10-lb. plots showed a 40 per cent ground cover of couch and the 30-lb. plots showed a 15 per cent cover compared with a 60 per cent cover on control plots.

Fifteen months after spraying, the 10-lb. plots were fairly heavily infested with couch grass (about 64 per cent) and the sisal was turning yellow; the 30-lb. plots were still relatively free from couch and had a good colour. The sisal in the control plots was yellow and the ground cover of couch was about 75 per cent.

These trials have encouraged growers to undertake large-scale trials on estates. Some of the new trial areas at the station have been sprayed with TCA and the couch is being successfully controlled.

A. F. NICHOLS,
Agricultural Officer (Sisal).

Synopsis

NURSERIES

The aim in a nursery is to obtain large planting material in the shortest possible time. This aim can be advanced by irrigation in dry areas and by a suitable spacing, 2 ft. x 9 in. is recommended. The fertilizer trials in progress are also indicating how the growth rate of nursery plants can be increased.

The second cycle of one of the nursery trials (A/3) corroborates the results of the first cycle, which were published in the 1952 report. Sisal waste, dug into the surface of the soil before the bulbils are planted, has accelerated the growth of young sisal more than inorganic fertilizers or sisal waste used as a mulch. However, there has been a response to sulphate of ammonia in both cycles when used by itself or in combination with sisal waste.

Phosphates have shown a response, only in the second cycle, which may indicate that the addition of phosphates will become necessary in later cycles.

Muriate of potash has not produced a significant response but there is a tendency for this fertilizer to depress the yield.

The weights of plants removed from an acre in the first cycle when sisal waste is not used or used are 40 and 58 tons respectively, in the second cycle the corresponding figures are 65 and 80 tons. These figures illustrate the fertility drain on the soil and the advantage which can be obtained by the use of sisal waste.

An interesting feature of (A/3) is the change which has taken place in the colour and texture of the soil over a period of three years. The plots treated with sisal waste are chocolate in colour whereas the other plots are reddish-brown. It is much more difficult to dig out the sisal plants in the plots which had no waste and when the plants are removed a mass of small roots can be seen on the surface where there was no waste. It is probable that the waste has encouraged a deeper penetration of roots.

Since the third cycle was planted in November, 1953, little rain has fallen and it is most noticeable that there is little or no weed growth in the plots that have not received waste whereas there is a good deal of weed growth on the waste plots.

Sulphate of ammonia is increasing the growth rate of young sisal but it is also known that it increases the acidity of soils. This coupled with the fact that sisal is a greedy user of calcium has made it necessary to establish a trial in which different kinds of nitrogenous fertilizers are used. This trial has made slow growth owing to a low rainfall.

PLANTING MATERIALS

Our trials (B/1 and B/2) have consistently shown that the bigger the planting material (up to a height of 21 in.) that is used in the field, the sooner the area will be ready for cutting.

An uneven stand of sisal leads to trouble and losses in every branch of an estate's activities as it increases the amount of supervision required for the first cut, encourages uneven poling and leads to inefficiency in factory operations. Consequently, when a new area has to be planted it is important to grade the planting material. Even nursery plants of a similar height will vary in weight and girth, hence a trial (B/4) was started in April, 1952, to ascertain which one of three factors or their combinations would give the most even stand. Grading for weight and for height has produced a noticeably more even stand than plants which were just chosen at random from a nursery.

A look-see trial was started during the year to investigate the effect of curing nursery plants for varying lengths of time before planting in the field. The plants were lifted from a nursery and left for periods of up to three months in the sun and under shade before the long and the short rains, i.e. during a hot dry season and during cloudy weather. Growth has been slow, owing to a shortage of rain, but all the material which was cured before the long rains and planted in April has started to grow without trouble.

The Plant Selection Trials (H/1 and H/2) are not likely to produce any spectacular new commercial varieties in the near future as it will be a long time before yields, fibre characteristics and numerous other attributes can be assessed. However, both the hybrids and local selections are producing leaves much faster than common sisal, which, in its turn, is producing a longer leaf. Although this is a line of work, which takes a long time to produce results, it is one which may be of the greatest importance to the future of the industry.

POPULATIONS AND SPACING

The maximum population which a given area will carry will depend on several factors such as soil fertility, rainfall and its distribution and altitude. In addition, the practical considerations of cutting and inter-row cultivation have to be considered. Any diminution of population from such a maximum will result in a reduction of fibre yield per acre. A population of 2,000 plants per acre is reasonably high and at the same time facilitates field work. All our trials have shown that a population of 2,000 per acre can usually be carried successfully in the sisal growing areas of the Colony without effecting a reduction in leaf length.

Having decided on a population, suitable spacings have to be chosen. The distance between plants in the row has a much greater effect on inter-plant competition than the distance between rows, hence the distance between rows should be reduced to the minimum consistent with the field operations that have to be performed. In a well grown sisal field 11 ft. between rows is about the minimum which will permit a cutter to take a light cut conveniently and in practice it is found that tractors and implements will damage leaves if the distance between rows is less than about 13 ft.

It is considered that the distance between plants in the row should not be less than 2 ft. 6 in. to 2 ft. 9 in., hence having chosen a population of 2,000 per acre and a distance between rows of 13 ft., a double row of 13 ft. x 3 ft. x 2 ft. 9 in. is a practical spacing that fulfils the above requirements. A single row spacing of 13 ft. by 2 ft. 9 in. gives a population of 1,218 plants per acre and it would be necessary to reduce the space between plants to 1 ft. 9 in. in order to obtain a population of 2,000.

Some people fear that double rows will reduce leaf length, but our trials D/3 to D/8 show that there are no grounds for such fears. Growers who have not had experience of double rows assume that weeding and cutting present insuperable difficulties with labour. This is not borne out in practice and, in fact, after about 18 months' growth, the sisal smothers the weeds in the double rows and weeding is impossible until the first cut is taken; this represents a reduction of about 20 per cent of the area that has to be weeded.

CUTTING

Trials have shown that heavy cutting adversely affects the subsequent development of sisal plants and it is recommended that 30-35 leaves should be left on a plant after it is cut, especially for the first time.

The external trials and B/2 are showing that an early first cut has the effect of checking the growth of the plant, thereby slowing down the natural increase in leaf length. It is probable that such an early check to growth in the cycle will retard poling, and thus increase the number of leaves of commercial length which the plant will produce, but the principle interest will centre around the total yield and number of leaves required to produce that yield. Preliminary trials at this Station have shown that the number of leaves required to produce a ton of fibre may vary from 100,000 in a first cut to 35,000 in a final cut.

Such variations are of major economic interest to the industry as the cost per leaf of cutting, transport and decortication may be the same, whereas the yield of fibre from the leaf may vary enormously. Careful records of leaf numbers and fibre yields are being kept in all trials in order to decide on the treatments that are likely to give the most economical results.

Improvement and Maintenance of Soil Fertility

Although the sisal plant is described, botanically as "Xerophytic", or capable of living where the water supply is limited, it is not correct to suppose that sisal requires an exceptionally dry climate to thrive. In fact, experience of sisal growing under widely differing climates in East Africa shows that sisal does respond to conditions generally favourable to most plants, such as a good soil and adequate moisture. The results are seen in the rapid production of long leaves, and on this, high fibre yields depend.

The economic future of the sisal industry depends on the fertility of its soil to the same extent as any other crop, consequently the main emphasis of the work of this Station is on this problem.

Information on this subject can only be amassed gradually, but already sisal waste, which is produced in large quantities on all estates, has given good results wherever it has been used. When it was applied to bulbils (A/3) and to young sisal in the field (F/1 and F/2) it gave better results than any other form of fertilizer, which was tested. The indications are that it is best applied by working it in to the surface soil.

The juice, which can be squeezed from sisal waste after decortication, contains a good deal of plant nutrients, but its application to the land seems to have had little effect on sisal growth. On the other hand, the pulp which remains after squeezing does benefit the sisal.

Sisal has responded to applications of double superphosphates, sulphate of ammonia and agricultural lime on the red soils in the Thika area (F/1 and F/2). Exploratory trials are, therefore, being planted on the varying soil types in the sisal growing areas of the Colony to gather information on this subject and at the same time further trials are to be started at the Station to ascertain what applications of sisal waste and fertilizers are necessary and economic.

The maintenance of soil structure is also receiving attention in the long-term trials (E/1, F/3 and F/4). In the Cultivation Trial (E/1) different systems of grass management are being tried with Rhodes grass, planted in strips between the sisal rows against land which is kept clean by frequent discing. The level of soil fertility in the trial area is high and so far the sisal has grown extremely well. The growth rates to date and yields from the first cut are similar for all treatments. Samples of soil from each plot are taken periodically and tested for pore space. Samples taken three years after the sisal was planted have not yet been analysed, but it was much easier to dig the sample pits where there was a grass cover than where the land was bare.

The Rotational Fertilizer Trial (F/3) and the Fertilizer, Waste and Grass Trial (F/4) which are planted on old sisal land at the Anglo-French Estate, Thika, also includes the use of sisal waste and fertilizers and clean cultivation v. controlled grass strips between sisal rows. These trials are now a year old and, so far, the sisal waste is the only treatment which has accelerated growth significantly. These trials should provide very valuable information in due course.

HERBICIDAL CONTROL OF WEEDS

The main work under this heading has been undertaken in order to find an economical means of controlling couch grass (*Digitaria scalarum*) which is more of a pest than a nuisance on many sisal estates. Messrs. Plant Protection Limited have co-operated in this work to a large extent. Different chemicals have been tried and, so far, the one that shows the greatest promise is sodium trichloroacetate, known as TCA.

The trials, J/2 and J/4, have shown that 10 lb. of TCA per acre can effect partial control for a short while, but the control of couch becomes progressively more effective as the rate of application of the chemicals is increased. These trials have given encouragement to some farmers to put down large-scale trials. Also, on two of our trials (F/3 and F/4) at the Anglo-French Estate, where the land was given the normal Estate cultivation, the area was sprayed with 30 lb. of TCA per acre before planting. Small patches of couch began to appear about eight months after planting and they were sprayed again with 20 lb. of TCA per acre, using a knapsack sprayer, during the November rains. It is estimated that the first application of TCA gave a control of about 87 per cent. The patches that have come back can be eliminated gradually by spot spraying. Although the rate was 20 lb. per acre, only 2.6 lb. were actually used on couch patches in an acre.

Heavy rates of application of TCA can eradicate couch entirely from an area, but reinfestation can easily occur at a later date. The chemical is still expensive in spite of the fact that its cost has been reduced from Sh. 6 to under Sh. 3 per lb. during the past three years. It would thus appear that it would be uneconomical to try to achieve complete eradication over large areas as sisal will grow well provided the couch is kept under reasonable control.

This work is gradually being extended to deal with weeds and other grasses, e.g. Giant Star Grass.

A. F. NICHOLS,
Agricultural Officer (Sisal).

REPORT ON EXPERIMENTAL WORK IN GENERAL HUSBANDRY

ANNUAL REPORT ON EXPERIMENTAL WORK IN RIFT VALLEY PROVINCE, 1953

(a) EUROPEAN AREAS

Eldoret District

Introduction

Rainfall in 1952 was extremely poor in its total and distribution. The record at the Experimental Farm was as follows:—

					<i>Inches</i>		<i>Days</i>
January	..	..	..	..	0.00	..	0
February	..	..	..	..	0.00	..	0
March	..	..	..	..	0.12	..	1
April	..	..	..	..	4.58	..	14
May	..	..	..	..	3.10	..	10
June	..	..	..	..	4.95	..	12
July	..	..	..	..	3.55	..	10
August	..	..	..	..	5.33	..	15
September	..	..	..	..	0.89	..	2
October	..	..	..	..	2.50	..	6
November	..	..	..	..	0.53	..	3
December	..	..	..	..	0.23	..	3
					25.78		76

Long dry spells were experienced from 7th May to 6th June and 4th to 24th July. After the 19th August very little rain fell, and it was not until October that again the odd inch was recorded.

Generally damage by pests and diseases was comparatively small. Oats in experiments suffered from Thrips. Greenfly was present but did little damage. Stalkborer in maize was present but could successfully be kept within limits with D.D.T. dressings.

Experiments

FERTILIZERS

A trial to determine the *residual and accumulative effects of phosphate on wheat* (9/9) was laid down on Field A of the Experimental Farm (7,000 ft.) in 1952.

The treatments are:—

- (1) Uganda Rock applied in first year only.
- (2) Uganda Rock in first and second years.
- (3) Uganda Rock in first, second and third years.
- (4) Soda phosphate in first year only.
- (5) Soda phosphate in first and second years.
- (6) Soda phosphate in first, second and third years
- (7) Double supers in first year only.
- (8) Double supers in first and second years.
- (9) Double supers in first, second and third years.
- (10) Control—no fertilizer.

The rates of the three fertilizers are—

Double supers (40.8 per cent citric soluble P_2O_5) at 206, soda phosphate (18 per cent) at 466 and Uganda Rock (3.6 per cent) at 816 lb. per acre.

All nine treatments and one control (no phosphate) were grouped in a (10 x 10) latin square with a plot size of 0.0193 acres.

All fertilizers were drilled by hand in 7-in. rows at sowing time and the whole trial was planted with 294M wheat at 32 lb. per acre on 25th June, 1952 and harvested on 9th to 11th December, 1952. Rainfall during this period was 18.5 in.

The results obtained may be summarized as follows (first year of trial):—

SCORINGS OF OBSERVATIONS OF GROWTH VIGOUR

<i>Treatment</i>	<i>Growth Vigour</i>			<i>Date to Ear</i>
No phosphate	..	..	2.4*	6/10/52
Uganda Rock	..	..	2.6	4/10/52
Soda phosphate	..	..	4.2	17/9/52
Double supers	..	..	4.3	17/9/52

*(1-5 by halves)

SUMMARY OF YIELD IN LB./ACRE

<i>Treatment</i>	<i>Mean Yield</i>	<i>Response</i>
	(±41.75 for nil-P) (±24.10 for remainder)	(±34.09) (1)
No phosphate	810.5	—
Uganda Rock	956.6	146.1
Soda phosphate	1144.9	334.4
Double supers	1261.6	451.0

SIGNIFICANT RESPONSES

	5 per cent	1 per cent
(1)	68	90

The responses due to the phosphates increase in ascending order for Uganda Rock, soda phosphate and double supers, and are all 1 per cent significant.

Another residual fertilizer trial with effects of phosphates on grass and subsequent effects on arable crops (9/10) was laid out in Field A of the Experimental Farm.

Its design is a 3^4 confounded factorial, single replication in nine blocks of nine plots each with 81 treatments (plot size 0.0193 acres) being a combination of—

- Phosphate at sowing time.—No phosphate, 10 cwt. Uganda Rock and 144 lb. double supers/acre.
- Phosphate annual top dressing.—Same treatments as those under (a).
- Nitrogen annual top dressing.—No top dressing, 1 cwt. sulphate of ammonia and equivalent N as sodium nitrate (145 lb./acre).
- Double supers to wheat following grass.—0-1-2 rates (not yet decided).

The grass (molasses, *Milenis minutiflora*) and 294M wheat were sown by hand in 7-in. alternating rows respectively at 15 and 55 lb. per acre. Double supers at sowing time were drilled by hand in each row on 27th June, 1952, whereas Uganda

Rock was broadcast on 12th June, 1952 and disced in. Both nitrogen fertilizers were broadcast on 28th August, 1952. The whole trial was planted on 30th June, 1952, and the wheat harvested on 16th to 17th December, 1952. Rainfall during this period amounted to 17.96 in. No clippings of molasses were obtained in 1952.

Results may be summarized as follows: before the application of the nitrogen top dressings growth/vigour observations were:—

No phosphate	2.8*
Uganda Rock	2.9
Double supers	4.5

*(1.5 by halves)

After the application of both nitrogen treatments in equivalent rates of nitrogen per acre observations indicate (*see table below*) that phosphate alone, and in presence of nitrogen improve growth though both together are not significantly better than phosphate alone. With regard to dates to ear, double supers alone, and in presence of nitrogen quicken ripening whereas this does not apply to Uganda Rock. Nitrogen alone has a very slight retarding effect.

P	N	oN	S.A.	S.N.
oP ..		2.6* 6/10/52	2.7 7/10	2.6 8/10
UR ..		2.8 3/10	3.1 3/10	3.1 4/10
DS ..		4.1 19/9	4.1 17/9	4.2 17/9

*Scoring: 1-5 by halves.

SUMMARY OF WHEAT YIELDS IN LB. PER ACRE

	Double Supers to indicator crop			Annual P-topdressing			oN	SA	SN	Mean
	(± 20.42) (1)			(± 20.42) (1)			(± 20.42) (1)			(± 11.79) (2)
No P	672.9	641.1	665.1	709.2	639.2	630.8	710.5	664.5	604.2	659.7
Uganda Rock ..	758.5	736.4	757.8	751.3	770.8	730.6	748.7	749.4	754.6	750.9
Double Supers ..	930.2	950.3	910.2	928.3	922.5	940.0	885.5	931.5	973.7	930.2
Double Supers to indicator crop				810.3 798.0 780.5	780.5 733.8 818.1	770.8 796.1 734.5	791.5 787.0 766.2	829.1 796.7 719.6	740.9 744.2 847.3	787.2 776.0 777.7
Annual P top- dressing.							779.2 801.9 763.6	789.6 787.0 768.8	820.0 743.5 768.8	796.3 777.5 767.1
Mean							(± 11.79) (2) 781.6 781.8		777.5	780.3

Significant Differences

	5%	1%	0.1%
(1) ..	61	84	116
(2) ..	35	49	67

ANALYSIS OF SOIL SAMPLES (11/6/52)

Block	pH	Total Exchangeable Bases ME%	Nit %	CaO ME%	K ₂ O ME%
I, II & III ..	5.5	7.63	0.202	4.11	2.52
IV, V & VI ..	5.6	7.79	0.216	3.70	1.82
VII, VIII & IX ..	5.5	6.51	0.197	3.49	1.35

The table of main interest is the top right hand one. Uganda Rock in presence and absence of both types of N does increase yields though not significantly while double supers does to a very high degree, 0.1 per cent. Double supers in presence of sodium nitrate is 5 per cent significantly more than double supers alone whilst its interaction with ammonium sulphate just fails to reach this level. Uganda Rock in presence of N does not increase yields at all compared with this phosphate alone. Both types of N decrease yields in absence of P and in the case of sodium nitrate 1 per cent level is reached. Main effect N (meaned over P) is negligible ($F=0.05$) which is caused by increase (NP DS—PDS) offset by decrease ($N-oNoP$). If meaned over N (that is main effect P), one obtains because of these N effects a 0.1 per cent significant response of Uganda Rock as well as of double supers, and the latter again is 0.1 per cent significantly more than the former. Interaction NP is overall 1 per cent significant ($F=5.75$).

FODDER CROPS

Several *crop mixtures* were planted in observations for *silage* purposes. The combinations were: oats and soyabean (Avoyelles), oats and Dolichos Lablab (Black S.A.O.), oats and field peas, oats and No. 4 Fulton sweet blue lupin, oats and purple vetch, and further oats alone and maize alone each planted with a basal dressing of 120 lb. double supers/acre. In all cases oats was the local variety, a mixture of Grey Algerian and Lampton. These plots were each 0.1 acres and in addition there were four small plots (each 0.01 acre) with four different fertilizer treatments.

No fertilizer, nitrogen (200 lb. ammonium sulphate per acre, broadcast as top dressing), phosphate (120 lb. double supers per acre), and nitrogen and phosphate.

In all cases the legumes were planted in rows without any fertilizer and oats at 50 lb./acre in 8-in. drills across with double supers the following day. Of all combinations oats and sweet blue lupin was the most successful, whereas with the other mixtures the legumes were crowded out. Decreasing the sowing rate of oats and a later planting date of the oats might counteract this and further trials are consequently needed.

Oats and No. 4 Fulton sweet blue lupin: the lupin was planted at a spacing of 18in. x 6 in. at 44 lb./acre and oats at 55 lb./acre across with 120 lb. double supers/acre on 27th to 28th May, 1953, and cut for ensilage on 20th to 21st August, 1953. The yield of fresh green matter was 9.6 tons/acre.

The four fertilizer treatments yielded as follows: no fertilizer 7.3, phosphate 14.4, nitrogen 9.3 and nitrogen and phosphate 15.0 tons/acre. Ammonium sulphate was broadcast on 30th July, 1953.

Oats alone and maize alone were also ensiled, and samples of all three silages were sent for analysis after three months—

	Oats	Oats and Lupin	Maize
	Per cent	Per cent	Per cent
Moisture	80.60	81.00	85.75
Ash	2.03	2.65	1.58
Crude protein	2.55	2.93	1.44
Ether extract	0.78	0.59	0.38
Crude fibre	6.12	6.16	5.21
Sol. carbohydrate	7.92	6.67	5.64
pH	4.4	5.1	4.2
Crude protein on dry matter basis	13.1	15.4	10.1

The first two silages were not quite acid enough and butyric acid odour was present. In both cases molasses is probably needed. The difference of crude protein per cent between the first two samples is very disappointing and fresh and ensiled samples have to be compared in futural trials.

GRASS

A *ley establishment trial* with a ley mixture of *Chloris Gayana* (Nzoia Rhodes) and Provence lucerne undersown in 294M wheat (13D/33/A) was laid down in Field A of the Experimental Farm in 1952. The treatments grouped in six randomized blocks of four plots each and with a plot-size of 0.0133 acres were as follows: 294M wheat alone in 7-in. rows, grass ley broadcast in pure stand, ley broadcast under wheat at 7 in. and ley broadcast under wheat at 14 in.

Wheat was sown with the drill at 82 lb./acre for each of both spacings on 1st July, 1952, and the Nzoia Rhodes grass and Provence lucerne broadcast by hand at 15 lb. and 5 lb./acre respectively on 3rd July, 1952. The whole trial received a basal dressing of 1 cwt. double supers per acre broadcast immediately prior to sowing, and also a top dressing of 1½ cwt. ammonium sulphate per acre broadcast on 20th August, 1952.

The wheat and ley mixture were cut on 19th to 20th December, 1952, and the rainfall was 17.96 in. In 1953 only one clipping (18th September, 1953) could be obtained but unfortunately because of the unfavourable season no cutting could be done on the 7 in. pure wheat plots of 1952 sown to grass in 1953.

Wheat emerged on 7th July and the grass on 22nd July, 1952. Lucerne established fairly satisfactorily but did not survive the dry season and nearly all plants gradually disappeared. Scorings on 26th September, 1952, indicated that 14 in. undersown wheat was slightly better than 7 in. undersown wheat but both were inferior to the pure 7 in. wheat and in addition ripened more quickly but also more unevenly. The grass in the undersown plots was slightly greener than the pure plots, and had already reached a height of 1½ ft., which would certainly raise problems with regard to combining of wheat. However, a postponement of the nitrogen top dressing until the year after and/or sowing the mixture later than the wheat will probably correct this.

Analysis figures of grass samples and yields are given below—

	<i>Per cent</i>					
Moisture	..	..	..	..	..	10.33
Ash	..	..	..	..	..	9.29
Crude protein	..	..	..	..	..	12.05
Ether extract	..	..	..	..	..	2.04
Crude fibre	..	..	..	..	..	25.44
N-free extract	..	..	..	..	..	40.85

SUMMARY OF WHEAT AND STRAW YIELDS IN LB./ACRE

<i>Treatment</i>	<i>Mean Seed Yield</i> (± 40.85) (1)	<i>Mean Straw Yield</i> (± 116.56) (2)
Wheat planted alone as normal	882.7	3076.3
Undersown wheat at 7-in. spacing ..	642.6	1920.8
Undersown wheat at 14-in. spacing ..	663.3	2121.1

Significant Differences

	5%	1%	0.1%
(1)	129	183	265
(2)	367	522	756

SUMMARY OF GRASS-CLIPPING YIELDS IN LB./ACRE

<i>Treatments</i>	<i>Mean Yield 1952</i> (± 94.32) (1)	<i>Mean Yield 1953</i> (± 50.24) (2)
Ley in pure stand	1202.2	584.5
Ley sown under 7 in. spaced wheat ..	1433.7	766.7
Ley sown under 14 in. spaced wheat ..	1260.9	659.9

Significant Differences

	5%	1%
(1)	297	423
(2)	158	225

Both undersown treatments show a definite decrease in yield of wheat compared with 7-in. pure wheat amounting to 25 per cent which is 1 per cent significant. No significant difference arises between the 7-in. and 14-in. undersown treatments.

This also applies to straw yield but the gap between straw yield of pure wheat on the one hand and 7-in. and 14-in. undersown wheat on the other hand is wider, 0.1 per cent significant, amounting to a 35 per cent difference of yield. Between undersown treatments, the 14-in. treatment is slightly higher in yield than 7 in. though the difference is not significant.

With regard to grass-clippings in 1952 and 1953, in the first year there are no significant differences between the pure grass, 7-in. and 14-in. undersown treatments though 7-in. undersown is higher in yield than the two other treatments which are of same order. This difference widens in 1953 to reach a 5 per cent significant level but also the 14-in. undersown treatment is gaining on the pure treatment.

Surprisingly, there is a considerable decrease of grass yield from 1952 to 1953 of roughly 50 per cent, which cannot be attributed to the peculiar 1953 season alone.

SOILS AND SOIL FERTILITY

An experiment to determine the effect of *various treatments on alleged crop reduction after ploughing in straw* (26/6) was laid down on Eureka Estates (7,700 ft.) near Sergoit Rock. The treatments were:—

<i>Time of Breaking</i>	<i>Rates of Ammonium Sulphate</i>
A = After harvest 22nd January, 1952.	D = 0 cwt./acre.
B = Beginning rainy season, 5th April, 1952.	E = 2 cwt./acre.
C = Prior to sowing time, 26th May, 1952.	F = 4 cwt./acre.
<i>Time of Application of SA</i>	<i>Treatment of Stubble</i>
G = At ploughing time, 22nd January, 23rd March and 23rd May, 1952.	K = No burning.
H = At sowing time, 20th June, 1952.	L = Burning, 4th January, 23rd March and 23rd May, 1952.
I = Half at time G and half at time H.	M = Raking off straw, dates <i>see</i> L.

All treatments, making 81 in total in factorial combination, were laid down in a 34 confounded factorial single replication in nine blocks of nine plots each with a plot size of 0.0174 acres.

Sulphate of ammonia was broadcast (where applicable) immediately prior to the ploughing (ox-plough). The whole trial was mechanically drilled in 7-in. rows with 294M wheat at 120 lb. per acre on 2nd July, 1952, with a basal dressing of 100 lb. double supers/acre and finally harvested by hand on 31st December, 1952. During this period the total rainfall was 13.05 in.

Results may be summarized as follows:—

Observation-scorings on 2nd October, 1952 show (*see* table below) an increasing response to rates of ammonium sulphate which, however, is independent of time of application. With regard to times of breaking "after harvest" appears superior and in the case of treatments of stubble this also applies to burning.

	D	E	F	K	L	M	G	H	I	Mean
A	3.9*	4.0	4.4	3.9	4.4	3.9	4.0	4.0	4.3	4.1
B	3.1	3.7	4.0	3.4	3.8	3.6	3.6	3.7	3.6	3.6
C	3.2	3.9	4.3	3.8	3.7	3.9	3.8	3.8	3.8	3.8
Mean	3.4	3.9	4.2	3.7	4.0	3.8	3.8	3.8	3.9	3.8

*Scoring: 1-5 by halves.

SUMMARY OF YIELDS IN LB./ACRE

	K	L	M	D	E	F	G	H	I	Mean
	(± 46.93) (1)			(± 46.93) (1)			(± 46.93) (1)			(± 27.09) (2)
A	794.0	880.8	904.4	874.4	814.4	890.3	892.3	804.8	882.0	859.7
B	730.1	845.0	801.6	704.6	801.0	871.2	776.1	774.8	825.9	792.3
C	762.7	735.9	859.1	753.1	828.4	776.1	828.4	678.4	850.8	785.9
K				738.4	748.7	799.7	732.7	714.2	839.9	762.3
L				795.2	806.7	859.7	818.2	804.2	839.3	820.6
M				798.4	888.4	878.2	945.9	739.7	879.5	855.0
D							774.8	725.0	832.3	777.4
E							812.5	776.7	854.6	814.6
F							909.5	756.3	871.8	845.9
Mean							(± 27.09) (2)			812.6
							832.3	752.7	852.9	

Significant Differences

		5%	1%
(1) ..		134	179
(2) ..		77	104

Of all main effects and interactions only the main effect of "time of application of sulphate of ammonia" is significant ($F=3.79$).

If the straw is not burnt or raked off, the earlier the ploughing the better and yield can be increased in addition if sulphate of ammonia is applied, ascending with rates especially when this nitrogen dressing is split for application at early ploughing and sowing time. However, these increases due to nitrogen are not significant.

If the straw is burnt, here again the earlier the ploughing the better. There was no significant difference between the yields obtained from burnt plots which received no nitrogen, or a low rate of application of this fertilizer, and those from plots where straw was ploughed in and 4 cwt. of sulphate of ammonia given. Where the straw was raked off and ploughing done early the yield without nitrogen was roughly equivalent to that obtained where straw was ploughed in and 4 cwt. of sulphate of ammonia applied. Even when straw is raked off, however, there appears to be a response to nitrogen. Nitrogen has been beneficial with all methods of stubble treatment but the responses were greater where the straw was burnt or carried off, which suggests that even higher rates of application of nitrogen must be given when straw is ploughed in to raise the yield to the same level as the other treatments.

An observation of a similar nature to the trial above was laid down on the farm of Mr. Begg near Kaptagat (8,000 ft.). The treatments, which were duplicated, in plots of size 0.02755 acre, were—

A = Nil (no ammonium sulphate or limestone).

B = Nairobi ground dolomitic limestone at 10,000 lb./acre.

C = Ammonium sulphate at 300 lb./acre.

D = 300 lb. ammonium sulphate + 10,000 lb. limestone per acre.

Both materials were broadcast on 7th May, 1953, with the necessary safeguards with regard to possible reaction between calcium and nitrogen, and disced in twice on 8th May, 1953. The observation was planted with 1066 wheat at 65 lb./acre in

7-in. rows and with a basal dressing of 150 lb. double super/acre on 8th May, 1953, and harvested and threshed by hand on 2nd to 3rd November, 1953. The rainfall during this period roughly amounted to 15 in.

The results are as follows:—

SUMMARY OF SEED AND STRAW YIELDS IN LB./ACRE

TREATMENTS	SEED		STRAW	
	Mean Yield	Response	Mean Yield	Response
	(± 52.58)	(± 74.36) (1)	(± 270.65)	(± 382.76) (2)
A	1,787.7	—	4,419.2	—
B	2,078.0	290.3	4,836.7	417.5
C	2,132.5	344.8	4,854.8	435.6
D	2,272.2	484.5	5,368.4	949.2

Significant Differences

		5%	1%
(1) ..		237	434
(2) ..		1,218	2,236

The application of limestone and ammonium sulphate separately does increase yields in ascending order and in both cases the 5 per cent significance level is obtained but the difference between these two materials is not significant. If both materials are applied together the response is 1 per cent significant, but here again this interaction is not significantly more than both materials applied separately. The same tendency of increases are found in straw yields, but none of the treatments reach a significant level.

Ol Joro Orok District

Introduction

The following table shows the rainfall recorded at the Experimental Farm (7,800 ft.) and is compared with the average monthly and total figures for the previous seven years:—

Month	1953	No. of days	Average 1946-1952 (incl.) Inches
January	0.42	4	0.34
February	0.02	1	0.42
March	0.78	6	2.06
April	3.74	13	5.94
May	4.25	13	4.54
June	3.84	15	3.34
July	4.96	14	5.78
August	4.72	20	7.10
September	1.55	8	3.09
October	1.23	9	2.26
November	2.66	15	1.47
December	1.47	10	2.11
	29.64	128	38.45

During the season April to September the rainfall was short and not so well distributed as in the previous year. Thus, though practically one inch more was recorded in 1953 than in the previous year the crops were not up to the standard of 1952.

Experiments

FERTILIZERS

A trial to determine the *optimum width of ridge* in relation to drainage and crop yields on vleis soils was laid out on Field V3 at Ol Joro Orok Experimental Station. The treatments (four in total, single replication) were the following widths of ridges: 12 ft., 18 ft., 24 ft. and 36 ft. The observation was planted with oats on 3rd June, 1954, and received a basal dressing of double supers.

The yields were—

Width of Ridge					Lbs. of Seeds per Acre
12 ft.	..	..	..	..	2,154.6
18 ft.	..	..	..	..	1,939.2
24 ft.	..	..	..	..	1,976.6
36 ft.	..	..	..	..	1,821.7

These results must be interpreted with the rainfall. In a year with a higher rainfall the optimum width becomes greater as was shown in a previous year.

A trial to determine the *residual and accumulative effects of phosphate with barley* (9/9) along similar lines as that one at Eldoret (see page 160) was laid down on the Experimental Farm in 1952. Treatments and rates of fertilizers are similar to those at Eldoret and are also grouped in a (10 x 10) latin square with plot size of 0.0124 acres.

All fertilizers were broadcast by hand immediately prior to planting on 23rd to 24th July, 1952, and the whole trial was mechanically drilled with Spratt Archer barley at 60 lb./acre in 8-in. rows on 24th July, 1952, and harvested by hand on 12th January, 1953. The rainfall from April to August was 28.77 in.

The results obtained may be summarized as follows (first year of trial):—

SUMMARY OF YIELDS IN LBS./ACRE

Treatments					Mean Yield (± 44.03)	Response (± 62.27) (1)
No phosphate	..	..	..	..	464.6	—
Uganda Rock	..	..	..	{	501.7	37.1
					546.1	81.5
					549.3	84.7
Soda phosphate	..	..	..	{	542.9	78.3
					524.3	59.7
					528.4	63.8
Double supers	..	..	..	{	660.6	196.0
					593.7	129.1
					624.3	159.7

Significant Responses

	5%	1%	0.1%
(1)	125	166	215

Only the responses due to double supers are significant, the first treatment at 1 per cent and two others at 5 per cent.

When the three treatments of each phosphate are meaned the responses become—

Treatment	Mean Yield	Response
	(± 44.03 for no P) (± 25.42 for remainder)	(± 50.84) (1)
No Phosphate	464.6	—
Uganda Rock	532.4	67.8
Soda Phosphate	531.8	67.2
Double Supers	626.2	161.6

Significant Responses

	5%	1%	0.1%
(1)	102	135	176
	72	96	124 (only valid for responses between the three Phosphates.)

Double supers increase yields to a 1 per cent level whereas the responses of the other two materials which are of same order do not reach any significance level. The increase due to double supers is 1 per cent significantly more than soda phosphate or Uganda Rock. Responses are erratic and small which can mainly be attributed to the method of application of the fertilizers.

A fertilizer trial with barley (9/12a) was laid down near Field 1 of the Farm in 1952. The treatments were double supers at 0-75-150, ammonium sulphate and muriate of potash (60 per cent) each at 0-25-50 lb./acre planted in a 3³ confounded factorial, double replication with six blocks of nine plots each with a plot size of 0.00331 acres. All fertilizers were drilled in the row by hand immediately prior to sowing and the whole experiment was planted with Spratt Archer barley at 70 lb./acre in 8-in. rows with the Planet Junior on 24th July, 1952.

The whole trial was harvested and threshed by hand on 9th January, 1953, and the rainfall from April to August amounted to 28.77 in.

Results are as follows:—

SUMMARY OF YIELDS, IN LB./ACRE

		Double Supers			Mean
		0	75	150	
		(± 35.93) (1)			(± 20.74) (2)
Sulphate of Ammonia ..	0	453.7	564.7	670.5	563.0
	25	489.0	710.9	710.9	636.9
	50	403.3	645.3	539.5	529.4

		Muriate of Potash			
		0	25	50	
		(± 35.93) (1)			
Sulphate of Ammonia ..	0	594.9	534.4	559.6	
	25	670.5	665.5	574.7	
	50	559.6	544.5	484.0	
Double Supers ..	0	463.8	473.9	408.4	448.7
	75	685.7	625.2	610.0	640.3
	150	675.6	645.3	600.0	640.3
		(± 20.74) (2)			
Mean		608.4	581.5	539.5	576.4

Significant Differences

		5%	1%	0.1%
(1) ..		104	141	188
(2) ..		60	82	109

Both rates of double supers increase yields to a same level, the response being 0.1 per cent significant. Sulphate of ammonia at 25 lb./acre increases yields to a 5 per cent level but doubling this rate decreases yields, though not significantly. Muriate of potash decreases yields in descending order with rates and with 50 lb./acre this decrease reaches the 5 per cent significance level.

Of all combinations double supers at 75 lb./acre and ammonium sulphate at 25 lb./acre seems the most satisfactory one, though an increase of roughly the same order and significance can be obtained with double supers alone at 150 lb./acre.

SOIL AND SOIL FERTILITY

An experiment to determine the effect of ammonium sulphate on alleged crop reduction after ploughing in straw (26/6) was laid down on Field 3 in 1952. The treatments were as follows:—

Time of Stubble Ploughing (disc)

A = After harvest (28th March, 1952).

B = After first rain (10th May, 1952).

C = ± six weeks before sowing (12th June, 1952).

Rates of Ammonium Sulphate

D = 0 cwt./acre.

E = 2 cwt./acre.

F = 4 cwt./acre.

Time of Application of Ammonium Sulphate

G = At ploughing time (see A, B or C).

H = At sowing time (2nd July, 1952).

I = Half at ploughing—and half at sowing time.

Grouped in a 3^3 confounded factorial single replication in three blocks of nine plots each of 0.04986 acres.

Ammonium sulphate was, where applicable, broadcast by hand immediately after the ploughing and disced in. The whole trial was mechanically drilled with Ceres 64 wheat at 70 lb./acre in 8-in. rows on 2nd July, 1952, with a basal dressing of 75 lb. double supers per acre, and harvested with the combine on 8th January, 1953. Rainfall from April to August was 28.77 in.

Results may be summarized as follows:—

SUMMARY OF YIELDS, IN LB./ACRE

	D	E	F	Mean
		(± 51.82) (1)		(± 29.92) (2)
G	1,006.1	1,457.4	1,403.9	1,289.1
H	1,417.2	1,494.1	1,654.6	1,522.0
I	1,153.2	1,420.6	1,571.0	1,381.6

	A	B	C	
		(± 51.82) (1)		
G	1,454.0	1,377.1	1,036.2	
H	1,400.5	1,611.1	1,554.3	
I	1,327.0	1,340.4	1,477.4	
		(± 51.82) (1)		(± 29.92) (2)
D	1,156.5	1,116.4	1,303.6	1,192.2
E	1,407.2	1,561.0	1,403.9	1,457.4
F	1,617.8	1,651.2	1,360.4	1,543.1
		(± 29.92) (2)		
Mean ..	1,393.8	1,442.9	1,356.0	1,397.6

Significant Differences

	5%	1%	0.1%
(1) ..	179	272	437
(2) ..	104	157	252

There are no significant differences between times of ploughing though the ploughing after the first rains appears the most satisfactory one. Both rates of 2 and 4 cwt. of ammonium sulphate increase yields in ascending order each at a 0.1 per cent level though the additional increase due to doubling the rate of sulphate of ammonia is not significant. With regard to times of application of sulphate of ammonia full rates at sowing time are 1 per cent (and nearly 0.1 per cent) higher yielding than if the full rates are given at ploughing time whilst splitting of the applications increases yields compared with full rates at ploughing time to nearly a 5 per cent level. Application at sowing time increases yields at a 5 per cent level compared with splitting of the rates.

Nakuru District

Introduction

The rainfall recorded at the four stations in the district is given below:—

	Njoro (7,000 ft.)	Molo (9,200 ft.)	Londiani (7,500 ft.)	Rongai (6,100 ft.)
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
January	0.35	0.38	0.47	—
February	0.11	—	0.08	0.05
March	2.47	0.52	0.16	0.95
April	3.06	3.75	3.91	3.29
May	1.71	3.06	3.29	2.15
June	3.53	5.18	8.25	2.91
July	1.34	3.23	2.84	3.15
August	3.83	6.90	5.28	2.10
September	1.39	2.37	1.34	1.18
October	2.00	1.65	2.79	2.17
November	3.13	2.72	0.74	3.93
December	1.35	1.12	2.89	1.00
TOTAL	24.27	30.88	32.04	22.88

After a rather dry year in 1952 in which the rains stopped early, 1953 was quite exceptionally dry.

Experiments

FERTILIZERS

An experiment to determine the *drainage requirements of vleis* (9/6) was laid out at the farm of Mr. Keppie at Londiani (7,500 ft.). The two treatments, "moled" and "unmoled", were alternating within six replications making six blocks of two plots each in systematic arrangement with a plot size of 1.2397 acres.

On the moled plots mole drains were made with a Miles Mole drainer with a 2½-in mole and 3-in. expander, six feet apart at a slope of 1 per cent and their ends only, which entered the bottom drain, were tiled. A cut-off drain surrounds the experiment at a distance of 40 yards. In addition, two guard moles were laid out along each of the long sides of the outside plots 3 ft. and 6 ft. from the plot edge.

The whole experiment was mechanically drilled with 318 wheat at 75 lb./acre on 25th June, 1952, and 6th June, 1953, and received a basal dressing of 100 lb./acre of double supers in 1952 and 1953 at sowing time. Both trials were harvested with the combine on 17th December, 1952, and 16th December, 1953, and rainfall was respectively 17.38 in. and 20.28 in.

The results may be summarized as follows:—

In 1951 when the experiment was laid out an additional treatment of rates of double supers (0–90 lb./acre) was included and results showed response to phosphate at a 1 per cent level but not to drainage. The seed from phosphate plots had a higher bushel weight and lower nitrogen content (respectively 56.9 and 2.42) than those without phosphate (respectively 53.4 and 2.81).

Observations in 1952 indicated that in the early stages of growth there appeared to be a slight difference in favour of the moled plots but this gradually vanished. In 1953, however, differences were very striking in the late stages when moled plots had a very good even crop whereas the unmoled plots were patchy and more weedy.

SUMMARY OF YIELDS, IN LB./ACRE

TREATMENTS	1952		1953	
	Mean Yield	Response	Mean Yield	Response
Unmoled	(± 22.93) 1,060.9	(± 32.43) (1) —	(± 19.50) 964.3	(± 27.58) (2) —
Moled	995.4	-65.5	1,200.9	236.6

Significant Differences

	5%	1%	0.1%
(1) ..	83	131	223
(2) ..	71	111	189

YIELDS IN LB./ACRE MEANED OVER 1952 AND 1953

TREATMENTS	1952	1953	Mean
Unmoled ..	(± 21.29) (1) 1,060.9	(± 21.29) (1) 964.3	(± 15.05) (2) 1,012.6
Moled ..	995.4	1,200.9	1,098.1
Mean	(± 15.05) (2) 1,028.2	(± 15.05) (2) 1,082.6	1,055.4

Significant Differences

	5%	1%	0.1%
(1) ..	67	95	138
(2) ..	47	67	98

ANALYSIS OF VIRGIN SOIL PROFILE

Depth	pH	Permeability in cm. per sq. cm./hour	N%	P ₂ O ₅	Exchangeable CaO ME%
<i>In.</i>					
0-9 ..	5.7	10.5	0.24	Low	0.17
9-18 ..	5.4	1.5	0.097	Very low	0.15
18-36 ..	6.0	1.4	0.099	Very low	—

In 1952, when double supers were applied at a basal dressing of 100 lb/acre, moled treatments showed a negative response compared with unmoled which, however, did not reach any significance level. In 1953 the reverse occurred and moled treatments showed a positive response which was highly significant, 0.1 per cent. If the analysis is done over both years the mean yields of both treatments still differ significantly though now 1 per cent in favour of moleing.

Rainfall and its distribution during the growing periods are given below being a necessary component of interpretation of results:—

	1951		1952		1953	
	Rainfall	Days	Rainfall	Days	Rainfall	Days
June	1.04		—		7.25	19
July	2.43		4.86		2.84	16
August	4.68		6.72		5.28	12
September ..	1.10		1.82		1.34	12
October	2.55		2.51		2.79	11
November ..	4.12		1.22		0.78	9
December ..	8.74		0.25		—	—
TOTAL ..	24.66		17.38		20.28	79

In the year 1953 the moled plots have given significant increases in yield over the unmoled plots. The reason probably is that in the month after planting the rainfall was much higher than average and the moles functioned satisfactorily removing excess water and allowing a good germination.

A fertilizer trial with three crops wheat, barley and oats (9/12) was laid down on *Marindas departmental plots* (9,200 ft.). The treatments comprised wheat, barley and oats in factorial combination with ammonium sulphate at 0–55–300 lb./acre and soda phosphate at 0–200–400 lb./acre, in a 3^3 confounded factorial, single replication in three blocks of nine plots each with a plot size of 0.0033 acres. Both fertilizers were drilled by hand in 7-in. seed rows at planting time; wheat and barley each at 75 lb., and oats at 55 lb./acre were also drilled by hand in the row on 23rd July, 1952. Barley and oats were harvested by hand on 12th January, 1953, and wheat on 4th February, 1953. The rainfall amounted to 36 in. from April to September.

Results are as follows: the whole trial was affected by green fly which appeared to do most damage to the wheat.

SUMMARY OF YIELDS, LB./ACRE

AMM. SULPH.				SODA P.	WHEAT			
					0	200	400	Mean
						(± 165.61) (1)		(± 95.61) (2)
0	..	..	..		113.4	85.1	217.4	138.6
55	..	..	..		9.5	66.2	9.5	28.4
300	..	..	..		37.8	18.9	94.5	50.4
						(± 95.61) (2)		
Mean	..	..	..		53.6	56.7	107.1	72.5

AMM. SULPH.				SODA P.	BARLEY			
					0	200	400	Mean
						(± 165.61) (1)		(± 95.61) (2)
0	..	..	..		9.5	151.2	245.8	135.5
55	..	..	..		9.5	85.1	226.9	107.1
300	..	..	..		37.8	37.8	13.2	29.6
						(± 95.61) (2)		
Mean	..	..	..		18.9	91.4	162.0	90.7

				SODA P.	OATS			
AMM. SULPH.				0	200	400	Mean	
					(±165·61) (1)		(±95·61) (2)	
0	..	..	..	434·8	1,068·1	605·0	702·6	
55	..	..	..	264·7	803·5	1,474·6	847·6	
300	..	..	..	841·3	605·0	973·6	806·6	
					(±95·61) (2)			
Mean	..	..	..	513·6	825·5	1,017·7	785·6	

Significant Responses

		5%	1%
(1) ..	..	573	868
(2) ..	..	331	501

MEANED OVER THE THREE CROPS

				SODA PHOSPHATE			Mean
AMM. SULPH.				0	200	400	
0				185.9	(± 95.61) (1) 434.8	356.0	(± 55.20) (2) 325.6
55				94.5	318.2	570.3	327.7
300				305.6	220.6	360.5	295.5
Mean	..	..		195.4	(± 55.20) (2) 324.5	428.9	316.3

Significant Responses

		5%	1%
(1) ..	..	331	501
(2) ..	..	191	290

There is a general response to soda phosphate alone for all three crops, but only with oats at the middle rate a significance level of 5 per cent is reached. Ammonium sulphate alone decreased yields for all three crops, though not significantly. Phosphate in presence of nitrogen does not increase yields for wheat but there are increases for barley and oats, the latter reaching at 1 per cent significance level with the highest rate of phosphate and middle rate of nitrogen.

E. BOSWINKLE,
Agricultural Officer (Experiments).

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(b) AFRICAN AREAS

As in previous reports the results are grouped under the ecological zones in which the trials were carried out to show the relative progress made during the year by investigations in each of the areas of contrasting farming conditions found within the Province. Results are presented in the case of some trials for 1952 as well as 1953 since the exigencies of the State of Emergency prevented their preparations last year.

High Bracken Zone

1. *Exploratory Fertilizer and Farmyard Manure Trial (Expt. 9/8/2)*

A 2³ factorial experiment with two replications only was started in the long rains of 1952 to test the effects of applications of phosphate, nitrogen and farmyard manure on crop yields. The treatments were:—

- (a) Double superphosphate at 2 cwt./Av. nil.
- (b) Sulphate of ammonia at 1½ cwt./Av. nil.
- (c) Farmyard manure at 10 tons/Av. nil.

Plot size was 1/80th acre and the crop was English potatoes. Manure and fertilizer were applied under ridge. The residual effects were tested in the short rains of 1952 by a crop of Bulrush Millet. Rainfall during the long rains was well below average although enough for crop growth. Short rains rainfall was average.

The High Bracken zone is characterized by extremely poor soils and an analysis from the site of the experiment gave the following results for 0-9 in. soil sample.

pH.	4.7	Base exchange capacity	ME/100g=27.58	per cent.
		Total Exchange Bases	ME/100g = 2.50	per cent
		„ CaO	ME/100g = 0.68	per cent
		„ K ₂ O	ME/100g = 0.546	per cent
		Organic Carbon	= 2.77	per cent
		N per cent	= 0.335	per cent
		P.205		Very low

The main result from the long rains was a significant increase in yield of potatoes following from the farmyard manure application and a significant negative interaction between farmyard manure and phosphate.

MEAN YIELD OF POTATOES IN LB. PER PLOT

	No Phosphate	Phosphate	Mean
No Manure ..	43.25	74.25	58.25
Manure ..	108.00	98.25	103.75
Mean	75.625	86.25	

The interaction MP = - 20.37 lb. per plot
 LSD between two main effect or
 interaction means P0.05 = 19.29 lb. per plot
 P0.01 = 28.55 lb. per plot

The general mean of all treatments=81 lb. per plot equivalent to 6,480 lb. per acre.

For the short rains planting of bulrush millet the plots were dug over and planting took place on the flat, not on ridges.

There was no significant residual effect from any of the treatments.

2. Grass Species and Manurial Trial (Expt. 13D/42)

As a result of the success during 1952 and early 1953 of Molasses grass (*Melinis minutiflora*) and Guinea grass (*Panicum maximum*) when compared in small, single plots to the commonly used Kikuyu grass (*Pennisetum clandestinum*) a replicated trial was put down to compare these grasses. The design was a 3^2 factorial, restricted to two replications. The treatments were:—

(a) Molasses grass v. Guinea grass v. Kikuyu grass.

(b) Farmyard manure at 5 tons/A. v. double superphosphate at $1\frac{1}{2}$ cwt./acre v. nil.

Plot size was 1/20th acre. Productivity of the grasses is measured by sample cuts each of which is followed by hard grazing by cattle. The latter graze one complete replication at a time, not plot by plot. The trial was planted in August, 1953, during the Gathano mist season. The results from the first cut are given below and demonstrate the effect of the manurial treatments on the establishment and initial growth of the grasses. The main effects recorded are the initial, significant superiority of Molasses and Guinea grass to Kikuyu grass under these conditions and the significant response of Molasses grass to phosphate. The response of Molasses grass to farmyard manure almost reaches significance.

TREATMENT MEANS. UNWILTED GRASS IN LB.—SAMPLE SIZE 22 SQ. YD.

		FYM	P	O	Mean
Molasses	..	57.08	99.65	32.48	52.42
Guinea	.. ..	49.95	50.01	57.30	63.07
Kikuyu	.. ..	8.01	7.62	5.95	7.19
Mean	.. ..	38.35	52.43	31.91	

LSD between two main effect (marginal) means

P0.05 = 15.70

P0.01 = 22.85

LSD between two interaction means=

P0.05 = 27.23

P0.01 = 39.62

The general mean of the 1st cut = 40.88 lb. per sample equivalent to 8,993 lb. per acre.

The trial is being continued.

3. Bracken Eradication and Kikuyu Grass Establishment Trial (Expt. 35/3)

This trial is sited in Location number one of Fort Hall District in country covered with thick bracken at, or just below, the lower edge of the High Bracken zone which is distinguished not only by the dominant species in the vegetation but also by the typical soil, an analysis of which has been given under 1 above.

The trial was started in the long rains of 1952 and is designed as a $4 \times 2 \times 2$ factorial, with two replications in blocks of eight plots completely confounding interaction S MP. The treatments are given below. Plot size is 1/5th acre.

- (S.) S1. Slash bracken commencing early long rains.
 S2. Slash bracken commencing early long rains and plant Kikuyu grass.
 S3. Slash bracken end of short rains and plant Kikuyu grass in the ensuing long rains.
 S4. Cut bracken, cultivate, take one maize crop underplanted to grass.
- (M.) Farmyard manure at 15 tons/A applied in grass planting holes or broadcast in treatment S1 v. nil.
- (P.) Double superphosphate at $1\frac{1}{2}$ cwt./A applied as for treatment M. v. nil.

Treatment S1 and S2 with their appropriate combinations of M and P were applied in the long rains of 1952. Treatment S4 plus its M and P treatments was planted to maize in the Gathano mist season during July and underplanted to grass in the following month. Treatment S3 was started in February, 1953, when the bracken was slashed. Due to Emergency activity in the area at various times during 1953 the manurial treatments were not applied, neither was grass planted on the S3 plots. On all plots after the specified dates for starting the slashing of bracken this process was repeated whenever fronds grew and reached the uncurling stage. The trial was grazed from 10th April, 1953, to 6th June, 1953, when the cattle were stolen by a *Mau Mau* gang. Grazing started again on 18th September, 1953, and the results given below cover the grazing days recorded during the first period and up to 16th December, 1953.

The maize yields were low and produced no significant differences between manurial treatments although plots dressed with farmyard manure were better than those without and yielded 1/3rd again as much grain. The mean yield of no farmyard manure plots was 75 lb., and of plots with farmyard 100 lb., maize on the cob. The mean number of grazing days per plot is shown below. The main results are that the grass planting treatments S2 and S4 were superior to the S1 and S3 treatments at the $P = 0.01$ level. It should be noted that the grass underplanted to maize was planted three months after that in treatment S2. Grazing of both these treatments started in April, 1953. There is, therefore, an advantage in planting with maize. With regard to the effect of manurial treatments, farmyard manure treated plots gave significantly more grazing than plots without manure. So far no treatment effect on the speed of eradication of bracken has been shown.

TABLE I

		S1	S2	S3	S4	Mean
M	..	22.5	55.5	13.5	56.0	37.0
P	..	8.5	30.5	16.0	40.5	24.0
MP	..	40.5	47.5	—	44.0	33.0
O	..	2.5	41.5	—	41.0	21.0
Mean	..	18.5	43.7	7.4	45.4	

TABLE II—M AND P TABLE

	P	O	
M	33	37	35.0
O	24	21	22.5
	28.5	29.0	

LSD between two S treatment means—Table I P.05 16.72, P.01 23.31.

LSD between two M and P treatment means—Table II P.05: 11.82, P.01: 16.48.

The general mean = 28.7 days per plot equivalent to 143 grazing days per acre up to 16th December, 1953.

Star and Kikuyu Grass Zones

1. Bean (*Phaseolus*) Variety Trial

Following unreplicated observational trials on locally grown dwarf bean varieties, five such varieties were put into a 6 x 6 latin square trial with Boston beans. This trial was started in the long rains of 1953 and repeated in the short rains of that year. In both seasons it was sited on the Embu experimental farm. In the long rains season there was a total of 19.05 in. of rain after planting. In the short rains season, 10.60 in.

The varieties under trial were:—

- | | |
|--|-----------------------|
| 1. Boston Beans | 4. Syi Maa |
| 2. Kisola | 5. Antwerp |
| 3. Nziu near "Black wax" shape differs | 6. Large White Kidney |

The long rains results showed no significant difference between Boston, Nziu, Kisola and Antwerp. Those four were significantly superior to Syi Maa and Large White Kidney at P.01.

LONG RAINS MEAN YIELDS—DRY BEANS IN LB.—PLOT SIZE 1/40TH ACRE

Boston	Nziu	Kisola	Antwerp	Syi Maa	L. W. Kidney
25.71	25.03	23.30	23.89	13.47	5.14

LSD between two means=P.05 3.73 lb.

P.01 5.08 lb.

The general mean=19.3 lb. per plot equivalent to 3.86 bags acre. (1 bag=200 lb.). The short rains results showed that Syi Maa outyields Boston and Antwerp at P=0.01 and Kisola at P=0.05. Nziu outyields Boston and Antwerp at P=0.01. L.W. Kidney outyields Boston and Antwerp at P=0.05.

SHORT RAINS MEAN YIELDS—DRY BEANS IN LB.—PLOT SIZE 1/40TH ACRE

Boston	Nziu	Kisola	Antwerp	Syi Maa	L. W. Kidney
13.41	16.75	14.96	13.41	17.83	16.46

LSD between two means = P0.05 2.26 lb.

P0.01 3.09 lb.

The general mean = 15.47 lb. per plot equivalent to 3.09 bags/acre.

2. *Ridging and Spacing of Cassava (Expt. 4/2)*

The object of this experiment was to obtain comparative yields of Cassava planted at different spacings and on ridges as opposed to on the flat. The trial was started in the short rains 1951. The treatments were Ridging v. Flat and 6 x 6-ft. spacing v. 4 x 4-ft. spacing. These were arranged in a 2² factorial design with four replications. The trial was sited at Embu on the Provincial Agriculture Training School Farm.

Leaf Mosaic affected three replications in the long rains of 1952 and these were harvested in August of that year. The fourth replication was harvested in February, 1953.

There were no significant differences between treatments but the trial was sited in a rather high rainfall area, over 40 in. average per annum, and had a somewhat unfortunate history so that the standard errors and least significant differences are high. The actual difference between yields at different spacings is probably worth recording.

MEAN YIELDS OF CASSAVA IN LB. PER PLOT 1/38TH ACRE

	Ridge	Flat	Mean
4 x 4	279	282	280.5
6 x 6	370	369	369.5
Mean	324.5	325.5	

LSD between two treatments means P0.05 = 113.9.

General mean = 325 lb. per plot.

Equivalent to 12,675 lb. per acre.

3. *Time of Breaking Land from Grass and the Effect of Manurial Treatment (Expt. 26/5 b 1)*

Difficulty has been experienced in successfully cropping in the first arable season land broken from grass. For native cultivators the normal time to break from grass or bush is during the long dry season preceding the long rains. In the higher rainfall areas the period without rain before the short rains is brief and if grass is broken at that time there is difficulty in cleaning it out prior to crop planting. It does not die from drying out as it does after cultivation in January to March. The following treatments were, therefore, combined in a trial with the object of improving yields from a first crop of maize sown in the long rains.

(B) Break mid short rains v. break in dry period prior to long rains.

(N) Sulphate of ammonia at 2 cwt./acre v. nil.

(P) Double superphosphate at 1 cwt./acre v. nil.

Three treatments were combined in a 2^3 factorial experiment with four replications arranged in blocks of four plots to completely confound interaction B.N.P. The trial was sited at Embu and the rainfall after planting in April was 24.47 in., 6.5 in. of which fell in August/September.

Treatment B, the short rains break was applied by ploughing in December. The rest of the plots were ploughed in mid March.

The whole trial was disced twice in early April. Phosphate was applied and planting took place on 11th April. This planting failed and the whole was re-planted on 21st April. Nitrogen was top dressed on the appropriate plots during May.

The only significant yield response to treatment was the increase given by the application of phosphate. The analysis of an eye score for the incidence of couch grass (*Digitaria scalarum*) made on 29th May showed a significant decrease (P0.01) on the short rains ploughed plots and higher incidence (P0.05) on the phosphate plots.

MEAN YIELDS IN LB. OF GRAIN PER PLOT—PLOT SIZE 1/20TH ACRE

Phosphate	No Phosphate	LSD = P0.05 17.69 P0.01 24.23	
70.15	49.46		

General mean = 59.8 lb. per plot.

Equivalent to 1,196 lb. per plot.

MEAN PER CENT OF COUCH GRASS PER PLOT

	Phosphate	No Phosphate	Mean
(B) Early Break ..	6.7	4.7	5.7
Late Break ..	16.2	9.7	12.95
Mean	11.45	7.2	9.3% Gen. Mean

LSD between two marginal means = P0.05 3.47
P0.01 4.75

4. Fertilizer Trial (Expt. 9/8/1)

As part of the general investigation into soils and fertilizer responses a 3^3 fertilizer trial with three nutrients each of three levels was started in the long rains of 1952 at the Embu Centre. There were two replications and second order interactions were partially confounded. The treatments were:—

N. at three levels 2 = 2 cwt. sulphate/ammonia per acre.
1 = 1 cwt. sulphate/ammonia per acre.
0

P. at three levels 2 = 2 cwt. double superphosphate per acre.
1 = 1 cwt. double superphosphate per acre.
0

K. at three levels 2 = 1 cwt. muriate/potash per acre.
1 = $\frac{1}{2}$ cwt. muriate/potash per acre.
0

In the 1952 long rains the experiment should have been planted to maize but due to delay in the delivery of fertilizers it was not planted until 10th May. The crop used was *Panicum mileacium*. P and K fertilizers were broadcast to the seed bed. N was top dressed between rows. Between planting and harvest there was only 5.42 in. of rain and yields were so low that no significant response to treatment was ascertained. However, a score by eye for growth was made at the end of June, a few days after the sulphate of ammonia had been applied, and this showed a significant response to phosphate at both levels.

The results are shown below:—

MEAN SCORE PER PLOT—MARKS OUT OF TEN

$$P0=3.8; \quad P1=5.7; \quad P2=6.8$$

$$\text{LSD between mean scores for main effects } P0.05 = 0.8918$$

$$P0.01 = 1.2121$$

Therefore P1 and P2 were superior to P at P0.01

P2 was superior to P1 at P0.05

In the following short rains the experiment was planted to dwarf beans (variety Boston) without reapplication of fertilizer treatments. Between planting and harvest there was 10.69 in. of rain. A significant response to nitrogen application at the lower level was recorded. This can be explained by the extremely dry year, the months between June application of sulphate of ammonia and October planting of beans, particularly being characterized by a low total precipitation, in light showers.

MEAN SHORT RAINS YIELDS OF BEANS IN LB. PER PLOT—PLOT SIZE 1/40TH ACRE

$$N0=13.49 \text{ lb.} \quad N1=16.91 \text{ lb.} \quad N2=15.03 \text{ lb.}$$

$$\text{LSD between main effect means} = P0.05 \quad 2.55 \text{ lb. per plot.}$$

$$P0.01 \quad 3.473 \text{ lb. per plot.}$$

The effect of N1 over N0 = +3.42 lb. per plot.

The effect of N2 over N0 = +1.54 lb. per plot and is not significant.

The general mean of all plots = 15.15 lb. per plot.

Equivalent to 606.00 lb. per acre.

In the long rains of 1953 all the treatments were reapplied at the original levels and the trial was planted to maize. The seasons rainfall from planting to harvest of the plots totalled 25.76 in. Phosphate and potash were applied before planting, in rows coinciding with the rows of maize plants and about 2 in. below the surface. Sulphate of ammonia was applied parallel to the rows and 2 in. from them when the maize was about knee height.

The application of double superphosphate at 2 cwt. acre gave an increase of yield over nil phosphate that was significant at P0.01. At 1 cwt. to the acre the significance was at the $P = 0.05$ level. The difference between double superphosphate at the 1 cwt. and 2 cwt. levels just failed to reach significance. There were no significant responses to other treatments or interactions.

MEAN YIELDS OF GRAIN IN LB. PER PLOT—PLOT SIZE 1/40TH ACRE

$$P0=60.1; \quad P1=76.7; \quad P2=89.5$$

$$\text{LSD between main effect means} = P0.05 \quad 13.87 \text{ lb. per plot}$$

$$= P0.01 \quad 18.85 \text{ lb. per plot}$$

The general mean = 75.4 lb. per plot

Equivalent to 3,016 lb. per acre.

5. Ridging, Mulching and Farmyard Manure Application (Expt. 9/13/1)

A trial combining the following treatments in a 2^3 factorial experiment with four replications was commenced at Embu in the long rains, 1952.

R. Ridging v. no ridging.

M. Farmyard manure at 5 tons/acre v. nil.

X. Mulching v. no mulching.

The interaction RMX was confounded. The manure was applied broadcast on the flat and on the appropriate plots the ridges were made up afterwards. On the flat plots which received manure it was dug in by hand. The experiment was planted to maize. The rainfall between planting and harvest amounted to 18.91 in. Immediately after planting there were light showers alternated with hot dry periods. In the unconsolidated ridges these conditions had an adverse effect on germination. An analysis of a plant count taken in May illustrates the effect of ridging treatment under these conditions.

Mean Number of Plants Per Plot

Ridge Plots Unridged Plots

91

162

LSD between two means

$P0.05 = 27.3$

$P0.01 = 37.4$

In all subsequent seasons in this trial the ridges have been consolidated by treading before planting and no adverse effect has been noted on the germination of maize or other crops planted on them.

In the final yields ridging was shown to have significantly reduced yield ($P0.01$). Manuring and mulching as main effects just missed significantly increasing yield.

MEAN YIELDS PER PLOT IN LB. OF GRAIN—PLOT SIZE 1/40TH ACRE

	Ridging	No Ridging	Mean
Manure	36.8	65.8	51.3
No Manure	30.8	51.0	40.9
Mulching	38.1	64.5	51.3
No Mulching	29.6	51.8	40.7
Mean	33.8	58.3	46.0=General Mean

LSD between two means = $P0.05 = 11.828$
 $P0.01 = 16.203$

The general mean = 46 lb. per plot

Equivalent to 1,840 lb. per acre.

Following the harvesting of the maize, the ridges were moulded up again and the flat plots dug over. In the short rains the trial was sown to dwarf beans (variety Boston) mulching was reapplied on the appropriate plots. The resulting yields showed a significant response. ($P0.01$) to the residual effect of the farmyard manure. No other treatment approached significance. Rainfall on the crop totalled 11.09 in.

MEAN YIELDS PER PLOT IN LB. OF DRY BEANS—PLOT SIZE 1/40TH ACRE

<i>Farmyard Manure</i>	<i>No Farmyard Manure</i>	<i>LSD Between Two Means</i>
19.51	14.87	P0.05 = 0.685 lb.

General Mean = 17.19 lb. per plot

Equivalent to 687.6 lb. per acre

In the long rains of 1953 a further application of five tons of farmyard manure was made to the manured plots, in this case ridges were split over the dung on the ridged and manured plots and on the flat plots it was again dug in by hand. The trial was again planted to maize. Rainfall from planting to harvest totalled 27.50 in.

The only response to treatment that reached significance was the increase due to the application of manure.

MEAN YIELDS PER PLOT IN LB. OF GRAIN—PLOT SIZE 1/40TH ACRE

<i>With Farmyard Manure</i>	<i>Without Farmyard Manure</i>
105.1	73.8

LSD between two means P0.01 = 11.68 lb. per plot

P0.01 = 16.00 lb. per plot.

The general mean = 89.45 lb. per plot.

Equivalent to 3,578 lb. per acre.

The experiment is being continued.

6. *Periodic Large Applications of Farmyard Manure Compared to Repeated Small Doses and Fertilizer Dressings (Expt. 9/13/4)*

The object of this trial is to establish over a range of four crops whether farmyard manure is better applied periodically in large doses or repeatedly each year in small doses and also to compare the value of the farmyard manure dressing itself to its N.P.K. content applied in fertilizers. The trial was started in the long rains of 1953 and is to continue over a number of years. It is arranged in four series, with in each series the four crops under test in the long rains are to be planted in rotation. Each series is out of phase in the rotation with the others so that all four crops are grown in each long rains. In the short rains of each year the whole trial is cropped with dwarf beans. The long rains cropping is shown below.

	Series I	Series II	Series III	Series IV
1953 ..	Maize.	Potatoes.	Beans.	Sunflower.
1954 ..	Potatoes.	Beans.	Sunflower.	Maize.
1955 ..	Beans.	Sunflower.	Maize.	Potatoes.
1956 ..	Sunflower.	Maize.	Potatoes.	Beans.

• Within each series the manurial treatments are contained in three replications of six plot randomized blocks, making 18 plots to each series. The manurial treatments are:—

- (1) 12 tons/acre of farmyard manure applied in 1953, 1956, etc.
- (2) 12 tons/acre of farmyard manure applied in 1954, 1957, etc.
- (3) 12 tons/acre of farmyard manure applied in 1955, 1958, etc.
- (4) 4 tons/acre of farmyard manure applied in each year.
- (5) The N.P.K. content of the 4 tons manure dressing applied in fertilizers in each year.
- (6) Nil.

In 1953 the analysis of FYM was:—

Nitrogen 0.7 per cent, phosphate 0.3 per cent, potash 1.7 per cent.

The trial was planted between 18th and 21st April, 1953. Maize harvested 9th October, 1953; potatoes harvested 29th August, 1953; sunflower harvested 1st September, 1953; beans harvested 21st July, 1953. Between planting and harvest Series I maize received 22.69 in. rain, Series II potatoes received 21.46 in. rain, Series III beans received 15.92 in. rain, Series IV sunflower received 21.46 in. rain. The potatoes were planted on ridges with manure and fertilizers placed beneath the ridges before planting. The other crops were planted on the flat, phosphate as double superphosphate was placed in the rows of maize and beans and broadcast for sunflower. Nitrogen as sulphate of ammonia was top dressed on the maize, beans and sunflower in the fourth week of May. Potash applied as muriate of potash was not available for placing in the seed bed and had to be applied as a top dressing to the fertilizer plots of all series in May. It was forked in, between the rows.

The site of the trial had been broken from permanent grass in September, 1952, and cropped with dwarf beans in the short rains of that year. It was evident as the trial progressed that there was still a good deal of fertility variation within the series and blocks. The only significant results were shown by the potato crop. Yields from 1953 12-ton application and from fertilizer were significantly greater (P.01) than from untreated plots or plots receiving four tons of manure.

MEAN YIELDS OF POTATOES IN LB. PER PLOT—PLOT SIZE 1/40TH ACRE

No Manurial Treatment	1953—4 Tons	1953—12 Tons	Fertilizer
164 lb.	182.7 lb.	240.7 lb.	259 lb.

LSD between two means P.01 = 54.13 lb.
P.05 = 38.05 lb.

The general mean = 211.6 lb. per plot.

Equivalent to 8,464 lb./acre.

In the short rains the whole trial was planted to dwarf beans without re-application of manurial treatments. In Series II following potatoes significant responses (P.05) were shown to the residuals of 12 tons of manure and of fertilizer.

MEAN YIELDS OF BEANS FOLLOWING POTATOES IN LB. PER PLOT

No Manurial Treatment	1953—4 Tons	1953—12 Tons	Fertilizer
11.13	12.67	17.33	16.50

LSD P.05 = 4.09; P.01 = 5.83.

The apparent significance at a probability of P.01 of the difference between the 12 tons application and nil is not confirmed by the F test which shows only a significant difference at P = 0.05.

The general mean of this series = 13.32 lb. per plot equivalent to 532 lb./acre.

In Series III following beans a significant response was shown to the residual of 12 tons of manure when compared to nil.

MEAN YIELDS OF BEANS IN LB. PER PLOT

No Manurial Treatment 12 Tons

14.88 lb. 23.00 lb.

LSD P0.05 = 6.7 lb. per plot.

The general mean of this series = 17.50 lb. per plot.

Equivalent to 700 lb. per acre.

In Series I following maize the test showed a significant increase due to the residual of 12 tons of manure but this was not shown in the F test and can only be taken as an indication. In Series IV following sunflower there were no significant responses to treatments but the mean yield 26.52 lb. per plot equivalent to 1,060 lb. per acre was much higher than for any other series. The tentative conclusion from the short rains results is that the initial soil variation is evening out and more consistant results are hoped for in 1954.

7. Clipping Trial to Evaluate Three Sown and Three Planted Grasses (Expt. 13 c/20)

In the long rains of 1952 a clipping trial was laid down with six grasses. It consisted of a latin square with long narrow plots from which sample cuts 33 ft. x 3 ft. were made with an Allen motor scythe. The grasses were *Melinis minutiflora* (Molasses grass) *Cenchrus ciliaris*. *Chloris gayana* (Rhodes grass) which were sown and *Panicum maximum*, *Cynodon dactylon* (Star grass) and *Panicum makarikariensis* which were planted. The rainfall from time of planting to the end of the year 1952 totalled 23.38 in. and was well below average, particularly in the long rains and the period of establishment of the grasses. 1953 was an average year for rain.

The value of the trial was strictly limited by the presence in most plots of adventitious *Panicum maximum* and actual production of the individual grasses was hard to assess.

It does, however, appear from the first cut analysis that Molasses grass was superior to all the other grasses in initial growth from establishment. The second cut yields for Rhodes include two plots that were "missing" in the first cut, having been ploughed out in error and reseeded, and the figure is accordingly rather high for this species. Apart from this the second and fourth cut figures illustrate the superior ability of *Panicum maximum* to recover in a dry period following cuts at the end of a rainy season. The production pattern of Rhodes grass observed generally in the Province with its initially slow start and good production in the 2nd year is illustrated by the mean yields of the 1st and 3rd cuts.

There is an indication borne out by field observation that Molasses grass does not recover well under the rainfall conditions in the Star grass zone of the Province.

The mean yields of four cuts are shown below. The trial has been discontinued due to the steady increase of *Panicum maximum* in all plots. *Cenchrus ciliaris* was never established and yields shown under that heading are entirely of adventitious grass.

1ST CUT 28TH NOVEMBER, 1952

Mean Yields in Lb. of Fresh Cut Grass—Sown and Adventitious

Molasses	Rhodes	P. max.	Cench.	Star	P. makarikari
81.38	59.78	57.75	57.4	50.8	41.8

General mean = 58.21.

In mean yield 14 lb. = 1 ton acre.

Two plots of Rhodes and one of Molasses were missing for this cut, LSD between the mean yields of Rhodes and Molasses $P0.01 = 6.42$ lb. LSD between the mean yields of Rhodes and other grasses $P0.05 = 4.51$ lb., $P0.01 = 6.20$ lb.

2ND CUT, 26TH MARCH, 1953

Mean Yields in Lb. of Fresh Cut Grass—Sown and Adventitious

Molasses	Rhodes	P. max.	Cench.	Star	P. makarikari
14.12	10.17	16.80	14.45	10.02	9.09

General mean = 12.44. In mean yields 14 lb. = 1 ton acre.

LSD between two means $P0.05 = 4.93$

$P0.01 = 6.73$

3RD CUT, 29TH MAY, 1953

Mean Yields in Lb. of Fresh Cut Grass—Sown and Adventitious

Molasses	Rhodes	P. max.	Cench.	Star	P. makarikari
59.8	73.8	69.5	59.8	55.6	49.5

General mean = 61.3. In mean yield 14 lb. = 1 ton acre.

LSD between two means $P0.05 = 14.2$

$P0.01 = 19.37$

4TH CUT, 15TH SEPTEMBER, 1953

Mean Yields in Lb. of Fresh Cut Grass—Sown Species Only

Molasses	Rhodes	P. max.	Cench.	Star	P. makarikari
8.33	5.5	17.25	0	2.16	4.0

General mean = 6.3 lb. In mean yields 14 lb. = 1 ton acre.

LSD $P0.05 = 4.96$

$P0.01 = 6.77$

Thanks are tendered to all those officers in charge of research departments, the Soil Chemist, Senior Pasture Research Officer and others who advised on or produced the designs for experiments, provided seed or planting material for trials and carried out soil and other analyses. Also to those District Agricultural Officers who carried out trials in their districts in spite of the difficult, prevailing conditions and the pressure of work arising from the State of Emergency.

H. B. AMBROSE,
Agricultural Officer (Experiments),
Central Province.

ANNUAL REPORT ON EXPERIMENTAL WORK IN COAST PROVINCE, 1953

Weather Conditions

The weather during the long rains season was not very favourable. The rains started late, planting was not possible until mid-April and thereafter cool wet weather for the next six weeks depressed the growth of cereals. June was dry and was followed by abnormally heavy rain in July and August which interfered with ripening and harvesting. In the short rains season growing conditions were good and the crops were satisfactory.

Ley Establishment Trials

A number of species of grasses were sown or planted in observation plots at Gedi, Makamini and the Shimba Hills during the long rains. Each plot was split to compare the effect of the following treatments on establishment: (1) 1½ cwt. double supers per acre, (2) 5 tons farmyard manure per acre, (3) a companion crop of sorghum, (4) the use of 3-ft. tied ridges. At Gede, Napier grass and *Panicum coloratum* var. *makarikariensis* were the most successful of the planted grasses but *Cynodon dactylon*, *Panicum maximum* and Pemba grass were also satisfactorily established. The sown grasses—*Cenchrus ciliaris*, *Eragrostis superba* and *Melinis minutaefflora*—were a failure. None of the treatments mentioned above appeared to have any appreciable effect. At Makamini, molasses grass and *Cenchrus ciliaris* were satisfactorily established from seed and star grass from planting. Phosphate and manure were both beneficial. At the Shimba Hills molasses grass, *Cenchrus ciliaris* and *Eragrostis superba* were successfully established from seed and *Panicum coloratum* var. *makarikariensis*, star grass and Pemba grass by planting. The most productive grasses during this first season were the *Panicum*, molasses, *Eragrostis* and *Cenchrus* in that order. The variety of star grass used was unsatisfactory. Pemba grass made an excellent cover and maintained growth well into the dry season. Phosphate and manure gave markedly improved growth and grazing cattle showed a preference for the plots which received phosphate. Ridging and the use of a companion crop were not beneficial.

Experiments on Land Resting

The use of a grass ley in rotation with arable is only practicable over limited areas at the Coast owing to the prevalence of tsetse fly which prevents the keeping of cattle. Where grass cannot be utilized by stock, it is probably not the best cover under which to rest land as it is unlikely to have any appreciable beneficial effect on the structure of the very sandy soils of the Coast. Several experiments have, therefore, been started to test the effect of other resting covers. One trial (No. 26/9) at Kibarani compares the effect of one, two and three years' rest under either star grass or pigeon pea. A second trial (No. 26/10), at Matuga, tests the effect of short-term rests, during the short rains of each year, under teff grass, velvet beans used as a green manure and velvet beans used as a mulch. A third trial (No. 26/11), also at Matuga, compares three-year rests under star grass, pigeon pea and weeds or cassava and weeds. In both the latter trials application of farmyard manure or phosphate, or both, once in three years, are compared with no manurial treatment. None of these trials have yet yielded results of interest.

Fertilizer Experiments

Fertilizer trials, of 3³ factorial design, were carried out at Matuga, Shimba Hills, Kibarani and Gedi, the treatments being: (1) nitrogen—0, 1 and 2 cwt. sulphate of ammonia per acre, (2) phosphate—0, 1 and 2 cwt. double superphosphate per acre, (3) potash—0, $\frac{1}{2}$ and 1 cwt. muriate of potash per acre. At Matuga and Shimba Hills, all fertilizer treatments were applied at the beginning of the long rains of 1952 but only nitrogen and potash were re-applied before the long rains of 1953. At Matuga there was a significant response to phosphate in both the long and short rains crops in 1952 but no residual response this season, although in the short rains the phosphate response only just failed to reach the significant level. The only significant result at this site in 1953 was due to nitrogen in the long rains crop of Dwarf Hegari sorghum. At the Shimba Hills, where phosphate gave a highly significant increase in yield in both seasons of 1952, the trial was a failure in the long rains of 1953 owing to damage by stock and in the short rains there were no residual effects. At Kibarani and Gedi the experiment was put down on new sites this season and all fertilizers were applied before the long rains. At Kibarani there were responses to both nitrogen and phosphate in the long rains but no residual effects in the short rains. At Gedi the site appeared to suffer from great soil variation and no responses were obtained, as was the case in 1952.

In view of the response to phosphate obtained at Matuga and Shimba Hills in 1952, two further fertilizer experiments were started at both sites this year. The first of these aims at testing the cheaper, but less readily available, phosphatic fertilizers, guano and Uganda rock, with and without superphosphate, and at obtaining information on residual effects and the frequency with which phosphate needs to be applied. The design is a 3³ factorial with the treatments—

- (a) No phosphate, 600 lb. guano per acre, 816 lb. Uganda Rock per acre.
- (b) No phosphate, 1 cwt. double supers per acre, 2 cwt. double supers per acre.
- (c) Three repetitive treatments to be decided later.

At the Shimba Hills there were responses to all forms of phosphate in both the long and the short rains. At Matuga the only response was due to the residual effect of superphosphate in the short rains. The second experiment is also of 3³ factorial design with the treatments (a) 0, $\frac{1}{2}$ and 1 cwt. double superphosphate per acre, (b) 0, 2 $\frac{1}{2}$ and 5 tons farmyard manure per acre, (c) Three repetitive treatments to be decided later. It aims at determining the interaction between manure and phosphate and the residual effects of each. Responses to both farmyard manure and phosphate were evident in both rains in this first year.

Ridging, Manuring and Mulching

Three 2³ factorial trials were begun in the long rains of 1952 at Matuga, Shimba Hills and Gedi to compare all combinations of the following treatments:—

- (a) 3-ft. tied ridges v. flat cultivation.
- (b) 10 tons farmyard manure per acre v. nil.
- (c) Mulch of dry grass v. nil.

At Matuga and Shimba Hills no re-application of treatments has been made since the long rains of 1952, the ridges merely being moulded up and the mulch added to as necessary. At Gedi the ridges were split and remade and a further application

of 10 tons of manure given before the long rains of 1953. The results for 1953 are summarized in Table 1.

TABLE 1—YIELDS OF SORGHUM GRAIN OR GRAIN SEED

SITE	SEASON	CROP	Mean Yield lb. p.a.	MAIN EFFECT OF					
				Ridging		Manuring		Mulching	
				lb. p.a.	%	lb. p.a.	%	lb. p.a.	%
Matuga	L.R.	Sorghum	835.6	-113.7	-12.7	+171.2*	+22.8*	+23.7	+7.2
	S.R.	Gram ..	147.5	-6.5	-10.8	+42.5	+33.7	+24.4	+18.0
Shimba	L.R.	Sorghum	1,051.0	+37.5	+3.6	+378.0*	+43.8*	+43.7*	+52.6*
	S.R.	Gram ..	487.5	+86.9*	+19.6*	+169.4*	+42.1*	+59.4	+13.0
Gedi ..	L.R.	Crop failed	—	—	—	—	—	—	—
	S.R.	Gram ..	165.0	-11.2	-6.6	+35.0	+23.8	-90.0*	-43.0*

*Significant response.

At Matuga significant yield increases were obtained from manure in both seasons of 1952 and from mulching in the short rains crop of green grain. This year the only significant response was that due to manure (third residual) in the long rains. In the short rains growing conditions were poor and part of the experiment had to be replanted. At the Shimba Hills a significant response to the 10 tons of manure applied before the long rains of 1952 has been obtained in all four seasons so far. Ridging gave a significant increase in the short rains this year, as it did with the sorghum crop in the long rains of 1952. Mulching gave a significant increase in the long rains this year but the increase due to this treatment with the grain crop in the short rains just failed to reach significance. At Gedi the long rains crops failed. The apparent significant decrease due to mulching in the short rains crop is most probably not a real effect of mulch at all, although no explanation can be offered for it. The mulch was not applied until 20 days after planting and at that time the stand over the whole experiment was uniformly good, but the final stand was very significantly lower on the mulched plots than on others. In the short rains of 1952 mulching gave a highly significant yield increase at Gedi.

In the above experiments the ridges are all 3-ft. tied ridges but in order to test the effect of larger ridges two 5 x 5 Latin square experiments were started at Matuga and Shimba Hills in the long rains this year. These trials compare 3-ft. and 5-ft. tied ridges, either split and remade annually or merely moulded up each year, and flat cultivation. There are no significant differences in this first season.

Cassava

At Matuga observations on the mosaic and brown streak resistance of a number of clones and varieties of cassava were continued. Forty-three cassavas were under observation, the majority being clones of mosaic resistant types bred at Amani but some "commercial" varieties were included. Single rows of 20 plants of each clone or variety were planted, alternating with rows of local material collected from African holdings in various parts of Kwale District and representing all the varieties commonly grown in that district. A great deal of the local material was infected with mosaic when planted and some of it had brown streak as well. Both diseases spread rapidly in the local material and after 12 months practically all plants showed marked mosaic symptoms while a random sample of roots examined for brown streak at the same time showed that 55 per cent of the plants were infected with this disease.

Records of the incidence of mosaic on all individual plants of all the types under observation were taken at monthly intervals for a year. A certain number of plants were first recorded as diseased, later as free from infection, and later still as diseased again. In the majority of cases this came about as a result of defoliation during the dry season, from January to early April, the symptoms thus being temporarily removed by leaf fall, but re-appearing again after new leaves were produced with the onset of the rains. In some cases, however, there appeared to be a genuine recovery from a mild attack of the disease. The monthly records are not presented here but the following table shows the percentage of plants with mosaic symptoms 12 months after planting. It will be seen that the majority of the Amani hybrid clones suffered very much less from the disease than the true cassava varieties.

At 12 months after planting the plants were dug up and all roots were examined for brown streak. The percentage of roots infected with this disease is shown in the Table on the following page. Infected roots were put into two categories according as to whether they showed extensive diseased areas which would affect the quality and value to a marked extent or only smaller infected areas of lesser importance. These results are not given here, but it may be mentioned that only two varieties, TA.186 and 37312E, showed a high proportion of roots which were only slightly diseased.

In June, 1953, eight of the most promising of the above cassavas, together with a local variety as a control, were included in a randomized block yield trial which also makes provision for determining the effect on yield of different periods from planting to harvesting.

A number of the Amani cassavas were also grown at Gombato Estate, where they became infected with mosaic to a much greater extent than at Matuga, possibly because they were subjected to more intensive and virulent infection at Gombato. Twenty-two varieties and clones were planted at Gombato in plots of approximately $\frac{1}{4}$ acre each and one-sixth of each of these plots was harvested at six different times, i.e. 8½, 12, 15, 18, 21 and 23 months after planting.

Since the incidence of disease was unusually high, the results obtained from these plots do not give a picture of the yield potential of the varieties under normal conditions and for this reason the yield figures are not presented. Opportunity was also taken to determine the ratio of tops to roots for each variety at each planting date and to assess palatability.

Cotton

Variety trials, of randomized block design, were planted at Matuga, Kibarani and Gedi to compare the three varieties, UK.48, S.47 and C.(50)17. Unfortunately, the local variety was not included in these trials. At Kibarani, UK.48 significantly outyielded S.47 which, in turn, was better than C.(50)17, but at the other two sites there were no significant yield differences between varieties. UK.48 showed greater Jassid resistance than the other varieties. Bacterial blight (*Xanthomonas malvacearum*) was present at all three sites, being most prevalent at Kibarani; C.(50)17 was most severely affected by this disease and S.47 suffered least.

A randomized block experiment to compare interplanting of cotton and maize with pure stands of both crops was put down at Matuga, Kibarani and Gedi, the treatments being:—

- (a) Plots divided, half sown to maize and half to cotton in pure stands.
- (b) Maize and cotton interplanted, maize sown early April.
- (c) Maize and cotton interplanted, maize sown late April.
- (d) Maize and cotton interplanted, maize sown early May.

TABLE 2—PERCENTAGE OF PLANTS SHOWING MOSAIC AT 12 MONTHS AFTER PLANTING AND PERCENTAGE OF ROOTS WITH BROWN STREAK AT THE SAME DATE

Variety	Origin	Mosaic %	Brown Streak %	Variety	Origin	Mosaic %	Brown Streak %
4318/18	Cassava x <i>M. glaziovii</i>	100.0	4.2	46240 ..	..	..	..
C.133 ..	"	0.0	0.0	T.A. 186	..	..	..
4558/1	"	0.0	7.3	4239/2 ..	..	..	..
4558/4	"	11.0	0.0	T.251 ..	..	..	..
4640/4	"	0.0	3.0	T.220 ..	..	..	..
4697/4	"	0.0	9.8	T.551 ..	..	..	..
46103/1	"	0.0	0.0	Msitu ..	..	..	..
46105/2	"	5.0	3.8	B.15 ..	..	..	..
46106/26	"	30.0	6.8	F.100 ..	..	..	..
46106/27	"	0.0	5.4	37244E	..	..	..
4315/3	"	5.0	1.0	37318A	..	..	..
4332/2	"	100.0	11.9	4029/17	..	..	..
C.117 ..	"	10.5	?	Binti Minsi	..	..	..
CP.175	"	10.0	0.8	Sareso ..	..	..	..
4556/3	"	0.0	0.0	C.756B(a)	..	..	..
4568/3	"	5.9	9.3	F.279 ..	..	..	..
4318/22	"	0.0	0.0	37312E.	..	..	..
C.56 ..	"	100.0	0.0	4026/20	..	..	..
C.136 ..	"	20.0	0.0	Alpin	Valenca	..	..
CP.184	"	16.6	0.0	Malindi	fine leaf	..	..
4558/3	"	20.0	17.3	..	..	..	..
4598/1	"	0.0	0.0	..	..	..	..

*All had primary infection.

Cotton was sown as near the optimum date as possible in all treatments and in treatment (a) maize was sown at the optimum date. Results this season were inconclusive.

Maize

Observation plots of the following short-term maize varieties were planted at Kibarani: Chester County, Ninety Day, Early Pearl, Silver King, Bushman, Kroonstad Robyn, British Honduras. Ninety Day and Early Pearl were the most successful but none of the varieties were as good as the local Coast types in this season.

The disease *Puccinia polysora* appeared in the Coast Province, and in other parts of East Africa in 1952, and a programme of intensive juvenile testing of local and introduced maizes for resistance to the diseases was inaugurated by E.A.A.F.R.O., in glasshouses at Muguga early in 1953. At the same time it was obviously desirable to carry out field tests and one of these was sited at Kibarani. A collection of 42 local and exotic varieties, supplied by E.A.A.F.R.O., was grown in alternate rows with local Coast maize which is known to be fully susceptible to the disease, the object being to test the resistance of the introduced types under field conditions and to transfer resistance to the local adapted variety. Difficulty was encountered in distinguishing resistant and susceptible plants before flowering as *P. polysora* did not build up in the field until after the plants had flowered. Nineteen lines showed signs of useful field resistance and 118 cobs in 60 combinations were obtained from them by selfing, sibbing and crossing.

Sugar

A 6 x 6 Latin square experiment on herbicidal spraying for weed control in sugar cane was put down at Ramisi Estate with the following treatments:—

- (1) Control.
- (2) Fernoxone, two applications as a pre-emergence spray.
- (3) YF.2618, two applications as a pre-emergence spray.
- (4) Fernoxone, one pre-emergence application followed by PCP oil and YF.2618 as post-emergence application.
- (5) Fernoxone, one pre-emergence application followed by TCA and Fernoxone as post-emergence application.
- (6) Fernoxone and PCP oil as post-emergence application.

Very good control of weeds, including monocotyledons, was obtained by pre-emergence spraying, Fernoxone being more effective than YF.2618, a single spraying of the former giving almost complete control for eight weeks. Where only post-emergence spraying was done (treatment 6) this was not successful. Pre-emergence sprays did not cause a reduction in the germination of the crop or damage it in any other way but post-emergence sprays caused some burning of the sugar cane leaves.

The two fertilizer and manurial experiments begun at Ramisi in 1952 were continued and the plant cane crop was harvested in January, 1954. The results have not yet been analysed but certain indications may be noted. In the first trial, which is a 3³ factorial NPK trial, there appears to have been a response to the higher level of nitrogen (4 cwt. sulphate of ammonia per acre) and to the lower level of phosphate (2 cwt. double superphosphate per acre). In the second experiment, which compared 0, 3, and 6 cwt. of sulphate of ammonia per acre, either alone or with 3 tons of mollasses or 10 tons of filter press mud per acre, there appears to have been a response to the higher rate of application of nitrogen and to filter press mud.

T. B. SPENCE,
Agricultural Officer.

ANNUAL REPORT ON EXPERIMENTAL WORK IN NYANZA PROVINCE, 1953

RAINFALL AT EXPERIMENTAL STATIONS, 1953

	Kakamega	Bungoma	Kisumu	Kibos	Miwani	Kisii	Homa Bay
January ..	0.20	0.30	2.39	1.22	1.54	1.68	1.12
February ..	0.61	0.00	1.54	0.64	1.30	0.75	0.00
March ..	2.19	1.58	1.12	3.65	2.85	3.11	4.38
April ..	16.30	13.54	8.75	5.96	10.48	10.24	5.63
May ..	6.62	8.48	4.62	2.51	3.88	7.93	5.30
June ..	6.83	5.03	6.00	5.25	7.16	7.78	5.17
July ..	2.43	3.00	0.77	2.25	2.85	2.16	2.18
August ..	6.46	4.73	0.85	0.74	1.61	4.03	4.03
September ..	2.08	2.92	2.67	2.36	1.23	6.50	1.88
October ..	8.03	8.28	2.20	2.77	5.01	5.24	4.96
November ..	7.72	4.23	5.54	8.70	6.06	7.11	4.46
December ..	2.66	1.66	0.94	2.62	4.32	4.15	2.52
TOTALS ..	62.13	53.75	37.45	38.67	48.29	60.68	41.63
Average 14 years ..	72.81	—	43.40	—	52.11	64.44	—

The rainfall during the long rains was considerably below average at all stations and less well distributed, but the short rains were greater and continued longer than usual, which made the totals for the year higher than they would otherwise have been, but still appreciably less than average.

The yields of long rains crops were rather below normal at all stations but short rains crops in general were good. Sugar cane at Miwani suffered much more severely than usual from drought in the 1952-1953 dry season and two trials on the lower black soil were destroyed by the drought.

Cassava Variety Trial (Expt. 4/1/3)

This trial at Kakamega was started in April, 1952, to test the yield of six mosaic resistant cassava varieties obtained from Uganda (having originated from Amani), at 7 different harvesting dates, and also to study the mosaic resistance and palatability of each variety. The design was three randomized blocks each containing seven plots for the seven harvesting dates, each plot being split for the six varieties. Whole plot size was 1/50th acre, split plot size 1/300th. The harvesting dates were to be—

1. At 12 months	..	..	..	..	April, 1952
2. „ 18 „	..	..	..	..	November, 1952
3. „ 24 „	..	..	..	..	April, 1953
4. „ 30 „	..	..	..	..	November, 1953
5. „ 36 „	..	..	..	..	April, 1954
6. „ 42 „	..	..	..	..	November, 1954
7. „ 48 „	..	..	..	..	April, 1955

The results of the first two harvests were given in the 1952 Annual Report. The results of the third and fourth harvests are shown below:—

Variety	Mean Yields of Fresh Roots, lb. per acre			
	3rd Harvest		4th Harvest	
Alpin Valenca	29,138.8	..	44,856.0	
Msitu	18,059.3	..	14,212.8	
Kru	17,545.0	..	19,555.2	
F.279	14,913.3	..	20,210.4	
37244 E.	11,888.3	..	15,876.0	
Binti Minsi	2,420.0	..	11,037.6	
Least sig. diff. ($p=0.05$) ..	10,527.0	..	—	

Before the third harvest some pilfering occurred, and before the fourth harvest this had become so bad that the data from this harvest could not be analysed statistically and necessitated abandoning the experiment at this point, and the above results should be treated with reserve.

The following conclusions may be drawn from the experiment as a whole:—

1. The variety Alpin Valenca gave the highest yield at each of the four harvesting dates, Binti Minsi the lowest. The other four varieties were variable in performance.
2. A palatability test after the first harvest suggested that Binti Minsi was the most palatable to local Africans.
3. No mosaic symptoms were seen on any of the varieties during the experiment.

Fertilizer Experiments (Expt. 8/8/2)

These experiments were a continuation of the work undertaken by the E.A.A.F.R.O. between 1949 and 1951 and taken over by the department in 1952. In 1953 there were 10 exploratory fertilizer trials in North and Central Nyanza, a rates of application trial at Kakamega and a trial to test residual effects on a rates trial fertilized in 1952 at Bungoma.

Exploratory Fertilizer Trials (Expt. 9/8/2A)

Of these 10 trials, four were sited in Bunyala and Kabras locations of the eastern division of North Nyanza, two in South Bukusu and Bukhaya locations of the western division of North Nyanza and the remaining four in Alego, N. Ugenya (2) and Samia locations of the western division of Central Nyanza, all sites being on African holdings. Each trial had one replication only of eight treatments consisting of all combinations of FYM at five tons per acre before planting, double superphosphate at one cwt. per acre, drilled before planting, and sulphate of ammonia at one cwt. per acre, applied about four weeks after planting. Plot size was 1/80th acre in the North Nyanza trials, 1/240th acre in Central Nyanza. The crops used for the trials were maize in North Nyanza, maize and sorghum in Central Nyanza. All trials were scored during growth and yield data was obtained from seven of them. The results may be summarized as follows:—

At the three sites in Bunyala location on mildly reddish-brown soil, there appeared to be a nitrogen response only while at the site in Kabras on more reddish soil a phosphate response only was suggested. The two sites in S. Bukusu and Bukhaya were on mildly reddish-brown soil overlying murrum in a less productive and rather drier area, and although not harvested, scoring suggested a response to FYM and possible smaller responses to phosphate and to nitrogen. The three sites in Alego and N. Ugenya were on similar soil

to the last two but in still dryer, less productive areas, with the rainfall during the 1953 long rains being lower and less well distributed than usual. During growth scoring suggested a fairly a general response to FYM, and less frequently to phosphate at these sites. The trial in Samia was badly sited and no conclusions could be drawn from it.

Fertilizer Rates Experiment (Expt. 9/8/2B)

An experiment to test four rates of application of double superphosphate and of sulphate of ammonia on maize was done at Kakamega. The design was a 4 x 4 factorial, with plot size 1/80th acre. The rates of application of each fertilizer were (a) nil, (b) $\frac{1}{4}$ cwt. per acre, (c) $\frac{1}{2}$ cwt. per acre, (d) $\frac{3}{4}$ cwt. per acre. The phosphate was applied in drills and covered lightly with soil before planting the maize in the same drills, while the sulphate of ammonia was applied in a band six inches above each crop row about four weeks after planting.

Significant increases in maize grain yield were obtained from the $\frac{1}{2}$ -cwt. rate of double superphosphate and from the $\frac{1}{2}$ -cwt. rate of sulphate of ammonia but the $\frac{3}{4}$ -cwt. rate of each fertilizer gave little or no extra increase. There was no significant interaction between the two fertilizers.

<i>Double Superphosphate</i>			<i>Mean Yield of Grain, bags per acre</i>
Nil	..	..	14.44
$\frac{1}{4}$ cwt.	..	..	15.36
$\frac{1}{2}$ cwt.	..	..	16.93
$\frac{3}{4}$ cwt.	..	..	16.86 (Least sig. diff. (p = 0.05) 1.89)

<i>Sulphate of Ammonia</i>			
Nil	..	..	14.44
$\frac{1}{4}$ cwt.	..	..	14.99
$\frac{1}{2}$ cwt.	..	..	16.89
$\frac{3}{4}$ cwt.	..	..	17.26 (Least sig. diff. (p = 0.05) 1.89)

Fertilizer Rates Residual Experiment (Expt. 9/8/2C)

Beans were used to measure residual effects of fertilizers applied in 1952 in a 4 x 4 factorial rates of application experiment on maize at Bungoma. Double superphosphate and sulphate of ammonia had each been applied at four rates, viz.:—Nil, $\frac{1}{2}$ cwt. per acre, 1 cwt. per acre and $1\frac{1}{2}$ cwt. per acre. There had been very large significant increases in maize yield from each of the two fertilizers, especially from the phosphate.

In 1953 there was a very large, significant residual effect from the two higher rates of phosphate application but not from the sulphate of ammonia, as shown by the yield of beans.

<i>Double Superphosphate</i>			<i>Mean Yield of Shelled undried Beans, lb. per acre</i>
Nil	..	..	94.5
$\frac{1}{2}$ cwt.	..	..	129.8
1 cwt.	..	..	217.2
$1\frac{1}{2}$ cwt.	..	..	238.1
(Least sig. diff. (p = 0.05)			83.8
(p = 0.01)			117.1

Farmyard Manure and Phosphate Trial (Expt. 9/13/7)

A 3 x 3 x 3 factorial experiment with two replications was started in the long rains at Kakamega and Kisii with the following treatments:—

- (a) Farmyard manure at nil v. $2\frac{1}{2}$ tons v. 10 tons per acre.
- (b) Double superphosphate at nil v. $\frac{1}{2}$ cwt. v. 1 cwt. per acre.
- (c) Three repetitive or residual treatments to be decided later.

Plot size was 1/40th acre and the crops used were maize at Kakamega and sorghum at Kisii. The farmyard manure was applied evenly and dug in, while the phosphate was applied in the planting lines before planting.

At Kakamega the $2\frac{1}{2}$ tons rate of farmyard manure gave a significant increase in maize yield but the 10-ton rate gave only a small extra increase which was not significant. The 1-cwt. rate of double superphosphate gave an increase in yield which was not significant, and there was no significant interaction.

At Kisii there was practically no increase in sorghum yield from $2\frac{1}{2}$ tons of farmyard manure but a large and highly significant increase from the 10-ton rate. The 1-cwt. rate of double superphosphate gave a non-significant increase, and there was no significant interaction.

<i>Farmyard Manure</i>					<i>Mean Yield of Grain, bags per acre</i>		
					<i>Kakamega: Maize</i>	<i>Kisii: Sorghum</i>	
Nil	..	..	..	..	15.47	..	8.28
$2\frac{1}{2}$ tons	..	..	..	..	16.97	..	8.36
10 tons	..	..	..	..	17.10	..	10.96
Least sig. diff. ($p = 0.05$)					1.36	($p = 0.05$)	1.50

Double Superphosphate

Nil	..	..	..	..	16.35	..	9.06
$\frac{1}{2}$ cwt.	..	..	..	..	15.92	..	8.48
1 cwt.	..	..	..	..	17.27	..	10.02

Tie-ridging Trials (Expt. 9/13/6)

A long-term tie-ridging trial was started in the long rains at Kakamega and Kisii, to continue over a whole cropping cycle embracing the main crops of the two respective areas. The design was a 5 x 5 latin square with plot size 1/48th acre and there were five treatments, namely—

- (a) Flat cultivation.
- (b) 3-ft. tie ridges, to be split and remade annually.
- (c) 3-ft. tie ridges, to be moulded up annually.
- (d) 5-ft. tie ridges to be split and remade annually.
- (e) 5-ft. tie ridges to be moulded up annually.

The ridges were made by hand and at both sites wimbi was the long rains crop used, sown broadcast. At Kakamega, by mistake, the ridges were not tied.

At both sites there was a depression in yield by ridging, the depression being greatest in the case of the 5-ft. ridges, but these differences were not significant. This result tends to confirm the conclusion reached in 1952 trials at these stations that tie ridging is unsuitable for small seeded crops in areas of high and intensive rainfall.

Mean Yields of Wimbi as percentages of Flat Treatment Yields

	<i>Kakamega</i>				<i>Kisii</i>
Flat	100.0	..	..	..	100.0
3-ft. ridges	87.0	..	..	..	92.17
5-ft. ridges	80.2	..	..	..	72.17

Star Grass Grazing Trial (Expt. 13 D.M./2)

An unreplicated observation trial was started at Kakamega to compare the effect of four pre-determined stocking rates on carrying capacity in an old-established grass field consisting predominantly of Star grass. The field was divided into four $\frac{1}{2}$ -acre paddocks which were stocked respectively by two, four, six and eight beasts, the cattle being put in and taken out of their respective paddocks as dictated by the state of the grass, according to normal farm-grazing practice. The trial was started at the beginning of May and for the eight months up to the end of the year the following beast-grazing days were obtained from the four paddocks:—

<i>Stocking Rate</i>	<i>Carrying Capacity</i> (Beasts per acre)
Two beasts per paddock	1.43
Four beasts per paddock	1.80
Six beasts per paddock	2.16
Eight beasts per paddock	2.51

These figures suggest that the progressive increase in carrying capacity with increasing stocking rate would continue with stocking rates even higher than eight per $\frac{1}{2}$ -acre paddock.

Rice Variety Trial (Expt. 23/1)

Nine varieties of rice, picked out from a larger trial in 1952, were tested at Namasaria in a lattice square trial with four replications. Plot size was $\frac{1}{55}$ th acre and all varieties were transplanted from seed beds. Unfortunately the transplanting extended over a period of some three weeks and subsequently the supply of irrigation was very irregular during the growing period and it is certain that yields were appreciably affected by date of transplanting. The yield figures were, therefore, not analysed statistically and varietal differences should be treated with some reserve.

<i>Mean Yields</i>	<i>Bags of Padi per acre</i>
<i>Variety</i>	<i>Yield</i>
Pishori	15.68
Rathkayaral 3753	13.48
Ambarikore	12.50
Bungala	10.33
Sindano	8.47
Mbuyu	4.52
Faya	4.27
2/16	3.40
Senna	2.92

Sugar Cane Variety (Expt. 29/2)

Five variety trials in the Miwani area were continued, of which two were harvested during the year. A variety trial at Kakamega was also harvested and a trial started in E. Konyango location in South Nyanza in 1952 was continued.

At Miwani, the variety trial of five varieties (Expt. 29/2/1) started in 1950 had its first ratoon harvest in November, 1953, the plant crop harvest having been taken in 1952. The design of this trial was a 5 x 5 latin square with plot size 1/75th acre. The varieties were: C.O. 421 (Miwani), C.O. 421 (Amani), C.O. 281, C.O. 419 and M.F. 2/40. At the first ratoon harvest in 1953, C.O. 421 (Miwani) and C.O. 421 (Amani) significantly out-yielded the other three varieties. This result adds further support to the change-over from C.O. 281 to C.O. 421 as the standard variety in the Miwani area, although at the plant crop harvest there had been no significant difference in yield between the two. The C.O. 421 (Miwani) and C.O. 421 (Amani), as at the earlier harvest, gave practically identical yields and it is concluded that for practical purposes they are one and the same variety.

Mean Yields—Tons of Cane per acre

<i>Variety</i>					<i>Yield</i>
C.O. 421 (Miwani)	..	..	..	..	31.27
C.O. 421 (Amani)	..	..	..	..	31.14
M.F. 2/40	..	..	..	..	25.96
C.O. 419	..	..	..	..	25.26
C.O. 281	..	..	..	..	23.31

Least sig. diff. ($p = 0.05$) 3.40
($p = 0.01$) 4.77

Four variety sorting trials at Miwani (Expt. 29/2/3) were completed in 1953. These trials were started in 1951 with the object of testing those of the varieties obtained from Amani which had not been included in any other variety trials. These varieties numbered 48 and the standard estate variety at the time, C.O. 281, was included in all four trials. Each trial, therefore, contained 25 varieties, and every variety was present in two trials, one on the upper red soil at Miwani and the other on the lower black soil. The two latter trials suffered so severely from drought early in 1953 that they could not be harvested, but the two trials on the upper red soil were harvested in June and September respectively. On the basis of observations during growth and harvest yields it was concluded that 40 of the varieties could be discarded as unworthy of further trial, apart from continuing to be maintained in the variety collection at Kisumu. The eight remaining varieties were considered to warrant further trial before any of them could be discarded. These were:—

C.O.411	C.O.205	C.O.312	C.O.432
C.O.426	C.O.407	C.O.301	C.O.213

At Kakamega a variety trial of eight varieties (Expt. 29/2/4) which was started in 1951 had its first (plant crop) harvest. The design was four randomized blocks, with plot size 1/60th acre. The varieties, and the yields of cane and of tops are shown below:—

Mean Yields—Tons per acre

<i>Variety</i>					<i>Cane</i>		<i>Tops</i>
C.O.421	..	..	..	..	66.6	..	14.1
B.3337	..	..	..	..	55.8	..	13.6
C.O.417	..	..	..	..	49.1	..	9.0
P.R.803	..	..	..	..	45.2	..	17.3
P.O.J.2725	..	..	..	..	41.0	..	14.2
Mayaguez 49	..	..	..	..	37.3	..	13.8
B.3172	..	..	..	..	25.0	..	6.2
P.O.J.2714	..	..	..	..	16.6	..	3.4

Least sig. diff. ($p = 0.05$) 29.8

On yields of cane, C.O.421 and B.3337 significantly out-yielded B.3172 and P.O.J.2714 while C.O.417 yielded significantly better than P.O.J.2714. Other differences were not significant. The trial has demonstrated that sugar cane can be grown very successfully at Kakamega, giving very satisfactory yields of cane and of tops. As a result of the trial C.O.421 and, to a lesser extent, B.3337, are the varieties now being recommended for growing by Africans in the Kakamega area.

Sugar Cane Spacing Trial (Expt. 29/5)

This trial was started in 1949 at Chemilil Estate to compare 4-ft., 5-ft. and 6-ft. spacing between rows, in a randomized block design with five replications. The variety used was C.O. 281. At the first (plant crop) harvest in 1951 there had been no significant difference in cane yield between the three spacings although there was a tendency for the closer spacings to yield slightly more. The first ratoon harvest was taken in June, 1953. The two closer spacings yielded slightly more than the 6-ft. spacing, but again differences were not significant.

Mean Yields—Tons of Cane per acre

<i>Spacing</i>		<i>Plant Crop</i>		<i>First Ratoon</i>
4 ft.	..	40.72	..	19.41
5 ft.	..	41.35	..	19.40
6 ft.	..	41.51	..	18.75

It is considered that the small non-significant decrease in yield with 6-ft. spacing would probably not outweigh its practical advantage in being more suitable for mechanical cultivation on an estate scale.

L. J. COLLINGS-WELLS,
Agricultural Officer (Experiments).

ANNUAL REPORT ON EXPERIMENTAL WORK IN SOUTHERN PROVINCE, 1953

Apart from three experiments at Makaveti, which are not here reported, experimental work in the Southern Province was confined to the Kampi ya Mawe Experimental Farm, near Makueni, which is in the drier part of Machakos District, with an average annual rainfall of rather less than 30 inches. In 1953 the total rainfall was 30.08 inches of which 9.34 inches fell in the long rains season (March–May) and 18.20 inches during the short rains (October–December). In both seasons the advent of the rains was followed by a dry spell which caused wilting, and necessitated replanting, of all crops except Dwarf Hegari sorghum. From the records available, it appears that at Makueni the short rains are rather more reliable, and of slightly longer duration, than the long rains. In 1953 the long rains were particularly poor and were immediately followed by hot, dry winds which prevented late planted crops from reaching full maturity, whereas the short rains were unusually favourable.

Ridging, Mulching and Manuring

Two 2³ factorial experiments were carried out with the treatments—

- (a) 3-ft. tied ridges *v.* flat cultivation.
- (b) Five tons of farmyard manure per acre *v.* nil.
- (c) Mulch of dry grass *v.* nil.

One of these, with only two replications, was started in the short rains of 1952, the other, with four replications, started in the long rains of 1953. In both trials farmyard manure was applied before the first crop and has not since been re-applied, the ridges were prepared for the first crop and have not been split and remade since, but merely moulded up. The original mulch has been added to as necessary to maintain a good cover. In these experiments the object has been to determine the effect of a good mulch, about three inches thick, provided by material carried in from outside the holding. Should this prove beneficial, it is intended subsequently to test the effect of a smaller amount of mulch, such as might be provided by crop residues and weeds. The results of the experiments to date are summarized in the Table on the following page.

Owing to insufficient replication the smaller was not of high precision and consequently, the increases due to ridging, although appreciable and consistent, did not reach significance level. Increases due to manuring and mulching were significant in the first and second seasons and again in the third season for bean haulms but not for seed. The long rains of 1953 were too poor for a successful bulrush millet crop, with the result that only straw was harvested from the smaller trial and a very poor grain yield, which showed no significant differences due to treatments, from the larger trial. In the short rains of 1953 there were significant responses in the yield of sorghum grain to both ridging and manuring but mulching only increased the straw yield significantly. The top few inches of soil was markedly moister under the mulch than in unmulched plots towards the end of the season but possibly in this favourable season water supply was not a limiting factor to grain production. It will be seen that there is evidence that, on average, all three treatments have been beneficial, particularly manuring and mulching. In the smaller trial the second residual effect of five tons of manure produced marked increases in bean seed and haulms, although only the latter was significant. There were no significant interactions.

EXPT.	SEASON	CROP	Mean Yield lb. p.a.	MAIN EFFECTS					
				Ridging		Manuring		Mulching	
				lb. p.a.	%	lb. p.a.	%	lb. p.a.	%
(a) 2 reps.	S.R. 1952	Beans, seed	310.6	+58.7	+20.9	+166.2*	+73.1*	+141.2*	+58.8*
	L.R. 1953	Millet, straw	1,982.5	+317.5	+17.5	+752.5*	+46.8*	+760.0*	+46.4*
	S.R. 1953	Beans, seed	270.0	+82.5	+36.1	+77.5	+33.5	+57.5	+23.8
	S.R. 1953	Beans, haulms	755.0	+80.0	+11.2	+125.0*	+90.2*	+510.0*	+102.0*
(b) 4 reps.	L.R. 1953	Millet, grain	172.1	+12.2	+7.3	+59.8	+42.1	- 9.7	-5.5
	S.R. 1953	Sorghum, grain	1,327.4	+181.7*	+14.7*	+264.7*	+22.1*	+22.2	+1.7
	S.R. 1953	Sorghum, straw	9,012.5	+1,185.0	+14.1	+1,590.0*	+19.4*	+1,400.0*	+16.8*

*Significant effect.

Fertilizers

An exploratory fertilizer trial, of 3^3 factorial design, in two replicates, with nitrogen at 0, 1 and 2 cwt. of sulphate of ammonia per acre, phosphate at 0, 1 and 2 cwt. of double superphosphate per acre, and muriate of potash at 0, $\frac{1}{2}$ and 1 cwt. per acre, was started in the long rains of 1952. All fertilizers were broadcast for the long rains, 1952 maize crop, but this set little grain and the records were subsequently destroyed in a fire. As it was considered that a mistake had been made in broadcasting the phosphate, all fertilizers were again applied before the short rains of 1952, phosphate being placed before sowing. No re-application of fertilizers was made for the long rains, 1953 crop, and only nitrogen and potash were applied for the short rains of 1953. Phosphate gave a significant response in the short rains of both years and nitrogen in the short rains of 1953.

Yields, lb. bulrush millet grain per acre

		O	P ₁	P ₂
S.R.'52	Bulrush millet	671.6	1166.1	1259.2
L.R.'53	" "	282.2	300.9	337.3
S.R.'53	" "	835.6	1364.4	1375.5
		o	n ₁	n ₂
S.R.'53	Bulrush millet	1076.1	1197.8	1302.8

In both the short rains seasons the increased yield due to the higher rate of application of phosphate was not significantly greater than that obtained from the lower rate of application and, even although the lower rate must be regarded as 2 cwt. per acre (1 cwt. broadcast followed by 1 cwt. placed), the increase in yield due to this application of phosphate from the three bulrush millet crops is highly economic. It will be observed that the residual effect of this lower rate of phosphate gave an increase of 63 per cent in the third crop after its application. In the long rains of 1953, when lack of rain was clearly the major limiting factor to yield, the increase due to phosphate at the higher rate just failed to reach significance.

Uniformity trials were carried out in 1953 in preparation for two experiments to determine the optimum rate of frequency of application of phosphate, the interaction between phosphate and farmyard manure, and the best way of applying manure. In the second trial the effect of manure applied as one large dressing once in three years or as three smaller annual dressings will be determined on four crops in a rotation.

Ley Establishment

Observation plots on ley establishment were put down in 1953 with three sown grasses—Rhodes, *Cenchrus ciliaris* and *Eragrostis superba*—and three planted grasses—Star, *Panicum maximum* and *Panicum coloratum* var. *Makarikiensis*. There were four plots for each grass, one each with no manure, phosphate, farmyard manure, and phosphate plus farmyard manure. Both 75 lb. per acre of double superphosphate and $2\frac{1}{2}$ tons farmyard manure had a markedly beneficial effect on establishment and subsequent growth and the two together had an even greater effect. Of the sown grasses Rhodes (Nzoia strain) was readily established, made excellent growth, and was much superior to the other two species, but the seed viability of the latter was low. The two *Panicums* both did well and were much better than the Star grass but a poor strain of the latter appears to have been used.

A 2⁴ factorial ley establishment trial was started in 1952 with the treatments (a) Star (planted) v. *Cenchrus ciliaris* (sown), (b) nurse crop of sorghum v. nil, (c) tied ridges v. flat cultivation, (d) five tons of farmyard manure v. nil. It was early evident that manure, and the combination of manuring and ridging were beneficial to establishment. The plots were not grazed until the short rains of 1953 up to which time the Star grass had produced better growth and cover than the *Cenchrus*. Since grazing, however, the *Cenchrus* has greatly improved and is now at least as good as the Star grass.

Fodder Crops

A number of observation plots of fodder crops and mixtures for the production of silage for dry season feeding were put down. Elephant grass, maize, bulrush millet, Sudan grass and Perennial Kavirondo Sorghums were grown alone and in mixture with spreading cowpeas, velvet beans, *Dolichos* sp. ex Kilima Kiu or *Glycine javanica*, and a comparison was also made of the effect of no manure, phosphate or farmyard manure. The stand of Elephant grass was initially patchy and poor growth was made, with the result that its yields were below those of the other Gramineae this year, but it is nevertheless probable that Elephant grass will prove to be the best fodder crop for the area. Maize gave the highest yields and there was little difference between Sudan grass and Perennial Kavirondo Sorghum but the ratoon crop of the two latter was very poor. Bulrush millet was less satisfactory. *Glycine javanica* was useless in mixture with the grasses owing to its slow growth. The remaining legumes all reduced the yields of the grasses and the total yield was only increased above that of the grasses in pure stand by the mixtures maize and *Dolichos*. Sudan grass and cowpea, and Elephant grass with cowpea or velvet bean. It is, however, unlikely that the spacings and relative planting times of legumes and grasses were optimal. Both phosphate and farmyard manure had a marked beneficial effect on growth, the phosphate plots probably being slightly better than those which received manure.

P. M. GHERSIE,
Assistant Agricultural Officer.

